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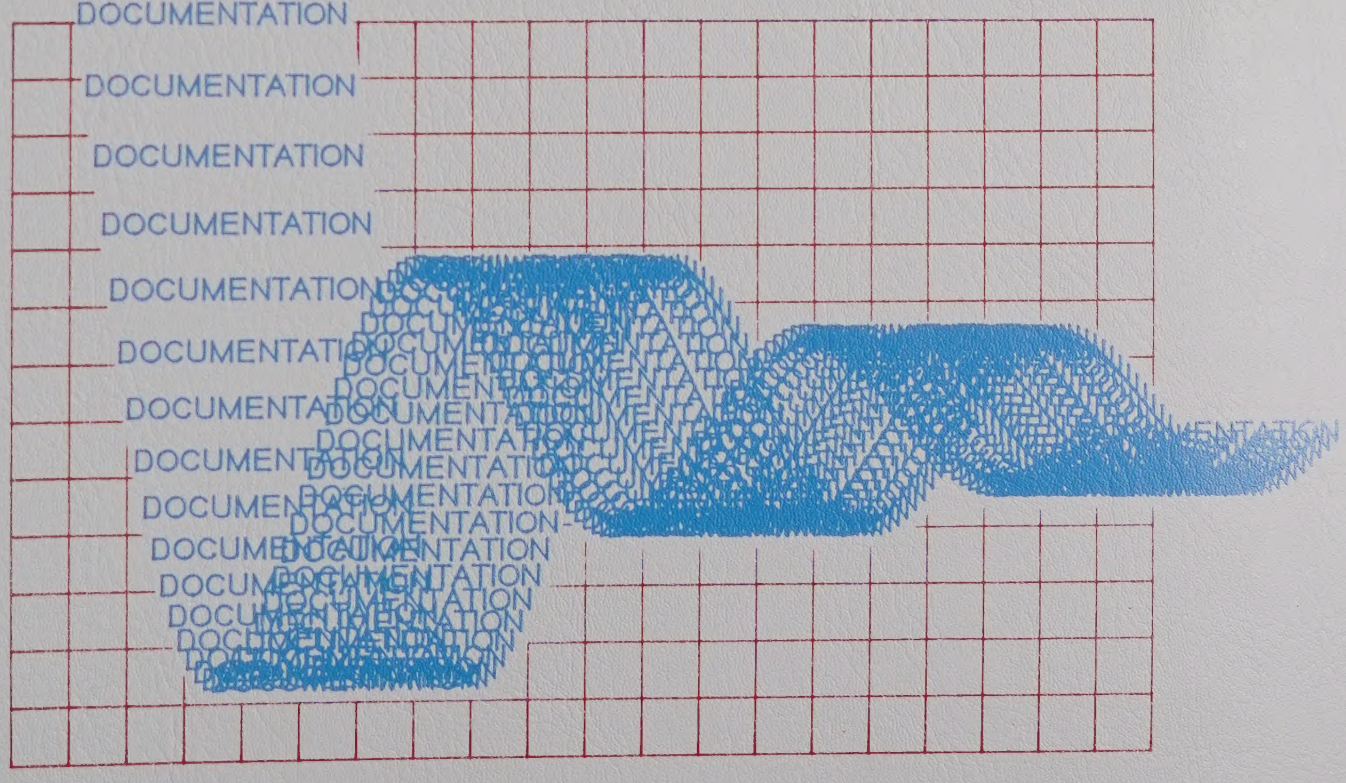

ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

SPECTRUM ANALYZER

FSEA20/30
1065.6000.20/30

FSEB20/30
1066.3010.20/30

FSEM20/30
1080.1505.20/1079.8500.30

Printed in the Federal
Republic of Germany

Certified Quality System

ISO 9001

DQS REG. NO 1954-03

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Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist nach ISO 9001 zertifiziert.

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Le système de gestion qualité de Rohde & Schwarz a été homologué conformément à la norme ISO 9001.

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Important Hints before Operation:

For instruments without the computer function FSE-B15:

- The disks used must have been formatted by the FSE itself or by MS-DOS. Pre-formatted disks can cause errors.

For instruments with the computer function FSE-B15:

- The drives D: and Q: are reserved for system software and must not be altered. Any changes in the drives D: and Q: can cause function errors.
- When operating a PS/2 mouse, a mouse driver has to be loaded via the designated entry in the autoexec.bat file.
- The files AUTOEXEC.BAT and CONFIG.SYS are write protected. User-specific programs which are to be executed automatically during the system startup must be entered in the file C:\AUTOUSER.BAT. Network drivers for option FSE-B16 must be entered in the file C:\NETWORK.BAT.
- After switching on the instrument, the startup process can be interrupted if required. This is achieved by pressing any key on the external keyboard repeatedly until "ABORT SYSTEM BOOT [Y/N?]" is queried on the display. The instrument works then in the DOS mode.

For all instruments:

- Aborting a hardcopy is not possible when printout is in progress. Print jobs in the queue can be deleted before printout has been started by pressing the HARDCOPY START key until the message "Hardcopy in progress. Abort?" is displayed. The length of the queue is two jobs.

Safety Instructions

This unit has been designed and tested according to the standards outlined overleaf and has left the manufacturer's premises in a state fully complying with the safety standards.

In order to maintain this state and to ensure safe operation, observe the following instructions, symbols and precautions.

1) When the unit is to be permanently cabled, first connect protective ground conductor before making any other connections.
2) Built-in units should only be operated when properly fitted into the system.
3) For permanently cabled units without built-in fuses, automatic switches or similar protective facilities, the AC supply line shall be fitted with fuses rated to the units.
4) Before switching on the unit ensure that the operating voltage set at the unit matches the line voltage.

   If a different operating voltage is to be set, use a fuse with appropriate rating.
5) Units of protection class I with disconnectible AC supply cable and plug may only be operated from a power socket with protective ground contact.

   The protective ground connection should not be made ineffective by an extension cable.

   Any breaking of the protective ground conductor within or outside of the unit or loosening of the protective ground connection may cause the unit to become electrically hazardous.

   The protective ground conductor shall not be interrupted intentionally.
6) Before opening the unit, isolate it from the AC supply.

   Adjustment and replacement of parts as well as maintenance and repair should be carried out only by specialists approved by R & S.

   Observe safety regulations and rules for the prevention of accidents.

   Use only original parts for replacing parts relevant to safety (e.g. power on/off switches, power transformers or fuses).
7) Also observe the additional safety instructions specified in this manual.

Explanation of Symbols Used

- Read operating manual, observe the safety symbols used

- Caution, shock hazard

- Protective ground connection

- Unit ground

- Equipotential (floating ground)

- Ground

Patent Information

This product contains technology licensed by Marconi Instruments LTD. under US patent 4609881 and under the corresponding patent in Germany and elsewhere.

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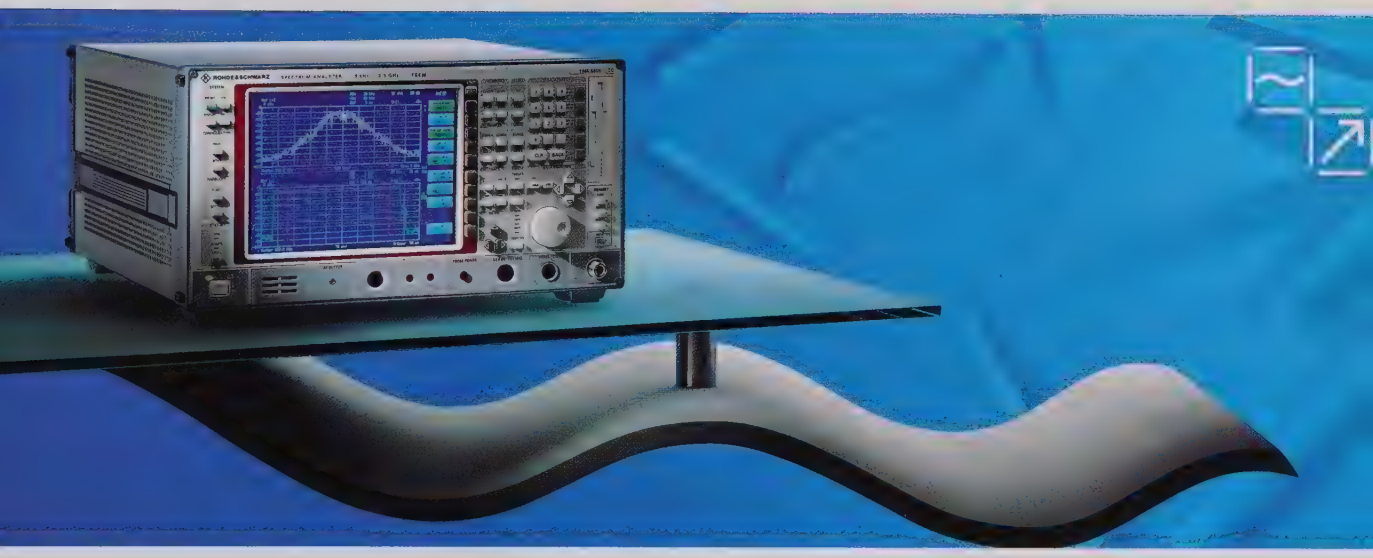


Spectrum Analyzer FSEA/FSEB/FSEM

Broadening our spectrum:

- Spectrum analysis
  with ultra-wide dynamic range
  Noise figure = 15 dB/T.O.I. = 15 dBm
  and
- Universal analysis of digital and analog modulated signals (option)
  BPSK, QPSK, π/4-DQPSK, QAM
  MSK, GMSK, AM, FM, PM
- High-speed synthesizer
  5 ms for full span (FSEA, FSEB)
- Refresh rate, quasi-analog
  25 sweeps/s
- Large LC display
  24 cm/9.5", active
- Future-proof modular design
  Customized solutions through wide variety of options
- PC-compatible
  Computer function enables PC applications

ROHDE&SCHWARZ

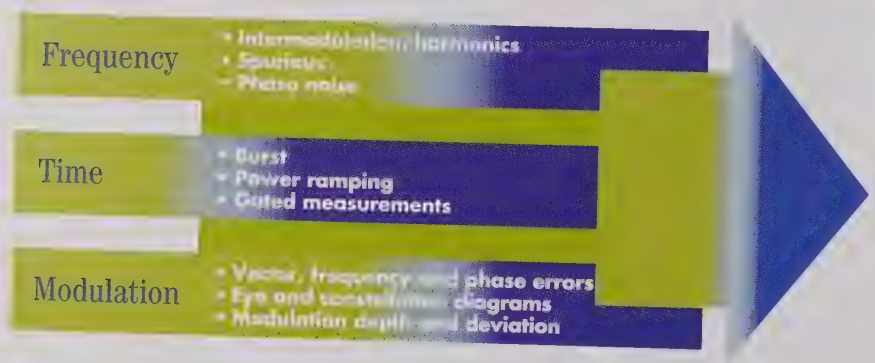
The spectrum analyzers from Rohde & Schwarz

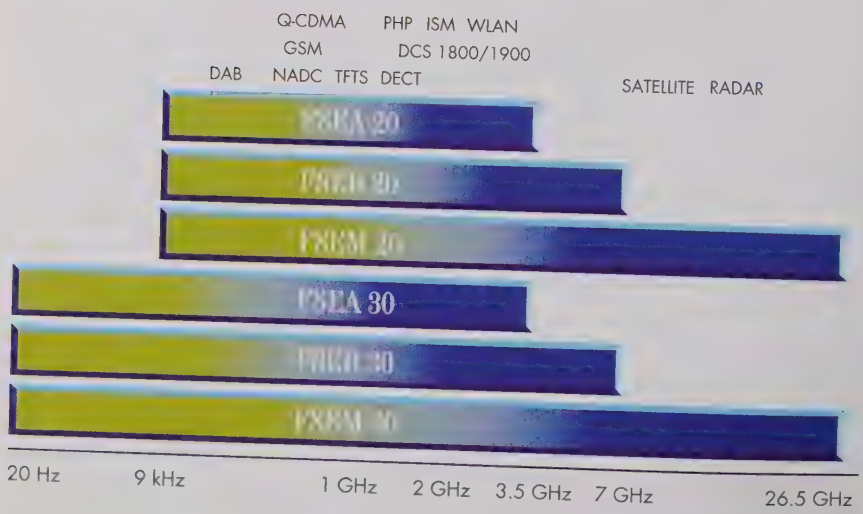
Overview

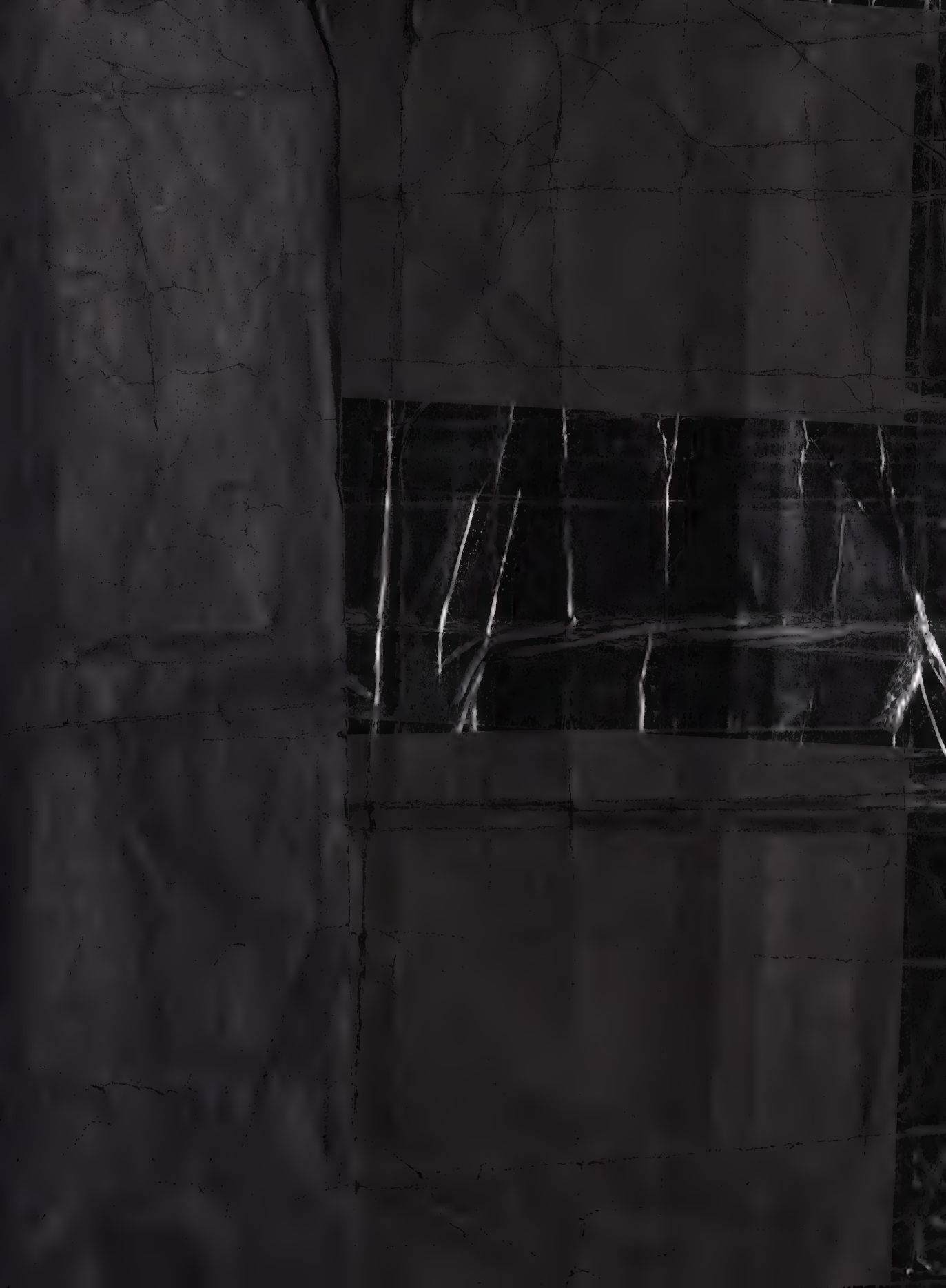
The FSE spectrum analyzers from Rohde & Schwarz have been optimized both for general-purpose measurements and meeting the stringent requirements of testing advanced digital communication systems. Extremely high measurement speed, future-proof modular design and excellent characteristics put the analyzers right at the top of today's market – at a price of a medium-range product.

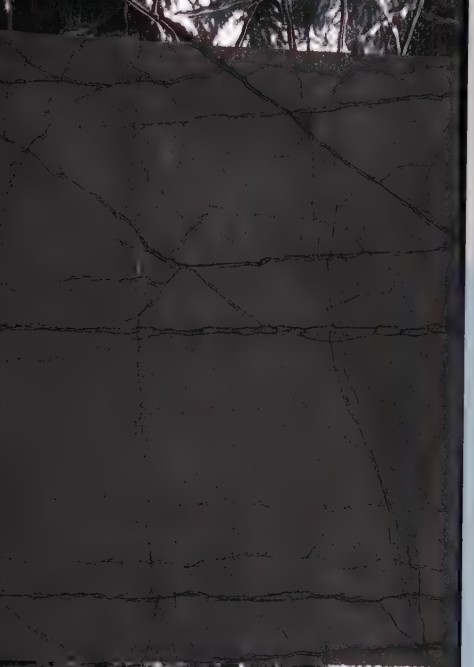
Characteristics

- Combines the following functions: spectrum analysis *and* analysis of digitally modulated signals (option)
- Fastest synthesizer worldwide incorporated in a spectrum analyzer
- Adaptation of all models to your specific requirements by means of a wide range of options.
  Easy upgrading of basic models into top-class models









Modular design for a safe investment

The FSE „option building blocks"

Option/function/software	Desig-nation	Availa-ble	FSEA 20	FSEA 30	FSEB 20	FSEB 30	FSEM 20	FSEM 30
Monochrome monitor	–	■	●	–	●	–	●	–
Colour monitor	FSE-B1[1]	■	○	●	○	●	○	●
Frequency from 20 Hz	–	■	–	●	–	●	–	●
Frequency to 3.5 GHz	–	■	●	●	–	–	–	–
7-GHz frequency extension	FSE-B2	■	○	○	●	●	–	–
Log level display (95 dB)	–	■	●	–	●	–	●	–
Log level display (105 dB)	–	■	–	●	–	●	–	●
Resolution bandwidths 10 Hz to 10 MHz, 4-pole filters	–	■	●	–	●	–	●	–
Resolution bandwidths 1 Hz to 10 MHz, 5-pole filters	–	■	–	●	–	●	–	●
Low phase noise and OCXO	FSE-B4	■	○	●	○	●	○	●
Vector signal analyzer	FSE-B7	■	○	○	○	○	○	○
Computer function	FSE-B15	■	○	○	○	○	○	○
Ethernet interface	FSE-B16	■	○	○	○	○	○	○
2nd IEC/IEEE-bus interface	FSE-B17	■	○	○	○	○	○	○
Noise measurement software	FSE-K3	[2]	○	○	○	○	○	○
GSM test software	FSE-K10	[2]	○	○	○	○	○	○

■ Available ● Incorporated in basic model ○ Can be retrofitted

[1] Factory-fitted only.

[2] Check availability with your lacal sales agency.

FSE options and their applications

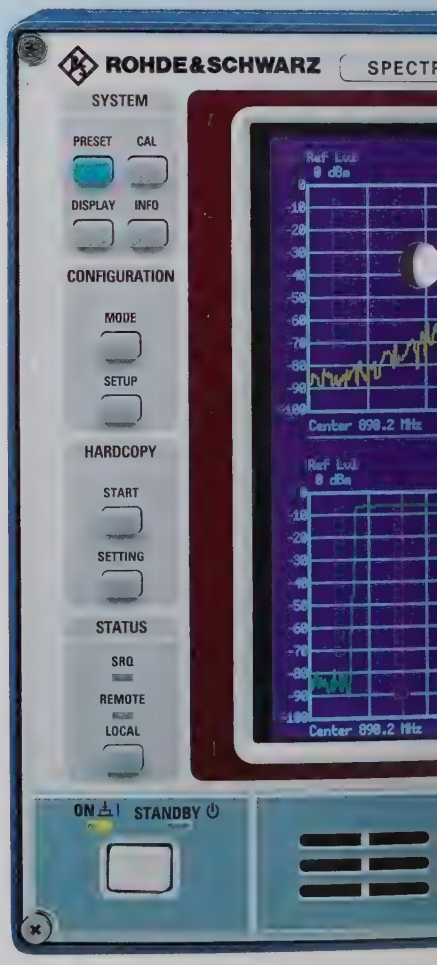
Digital mobile radio systems	Analog mobile radio systems	TV and CATV	AM and FM sound broadcasting	General-purpose RF measurements		
○			○		FSE-B2	7-GHz frequency extension
○	●		●		FSE-B4	Low phase noise and OCXO
●	○	●			FSE-B7	Vector signal analyzer
○			○		FSE-B15	Computer function
			○		FSE-K3	Noise measurement software
○					FSE-K10	GSM test software

● Required ○ Recommended

Getting down to analysis

Specifications in brief

- Resolution bandwidths 10 Hz to 10 MHz (models .20), 1 Hz to 10 MHz (models .30), adjustable in steps of 1/2/3/5/10
- Displayed noise floor –150 dBm (typ.) in 10 Hz bandwidth
- 3rd-order intercept point +15 dBm
- 1-dB compression point of RF input >+10 dBm
- Phase noise at 10 kHz from carrier –123 dBc/Hz
- Total measurement error up to 1 GHz <1 dB
- AM/FM demodulator (with built-in loudspeaker and headphones connector)
- Internal RF trigger
- 5 ms full-span sweep time with fully synchronized sweep (FSEA, FSEB)
- 1 µs zero-span sweep time
- Pretrigger and trigger delay
- Gated sweep



Vector analysis for digital communication

The analyzers of the FSE family combine the capabilities of high-end RF spectrum analysis with those of universal digital-signal demodulation and analysis. This becomes possible with the vector signal analyzer option. The spectrum analyzer function offers the wide dynamic range necessary for many measurements on digitally modulated signals (eg burst measurements), and the vector signal analyzer option adds demodulation capability to bit stream level for

- BPSK
- QPSK
- π/4-DQPSK
- QAM
- MSK
- GMSK

All this is backed up by a variety of display types:

- Eye diagrams
- Vector and constellation diagrams
- Frequency and phase error
- Vector error

With a spectrum analyzer of the FSE family, you are perfectly equipped for the future of digital communication.

Modularity safeguards investments

Series FSE analyzers are of modular design throughout. From the wide variety of options, you can choose exactly those needed for your particular application (see table on folding page).

You thus get an instrument tailor-made to your requirements and pay for no more than what you actually need. At the same time, you can feel sure that FSE will grow with your tasks and requirements as virtually all options can be retrofitted and model .20 units can easily be upgraded later to nearly the same performance as provided by top-class models .30. Even extending the frequency range from 3.5 to 7 GHz is no problem with option FSE-B2.

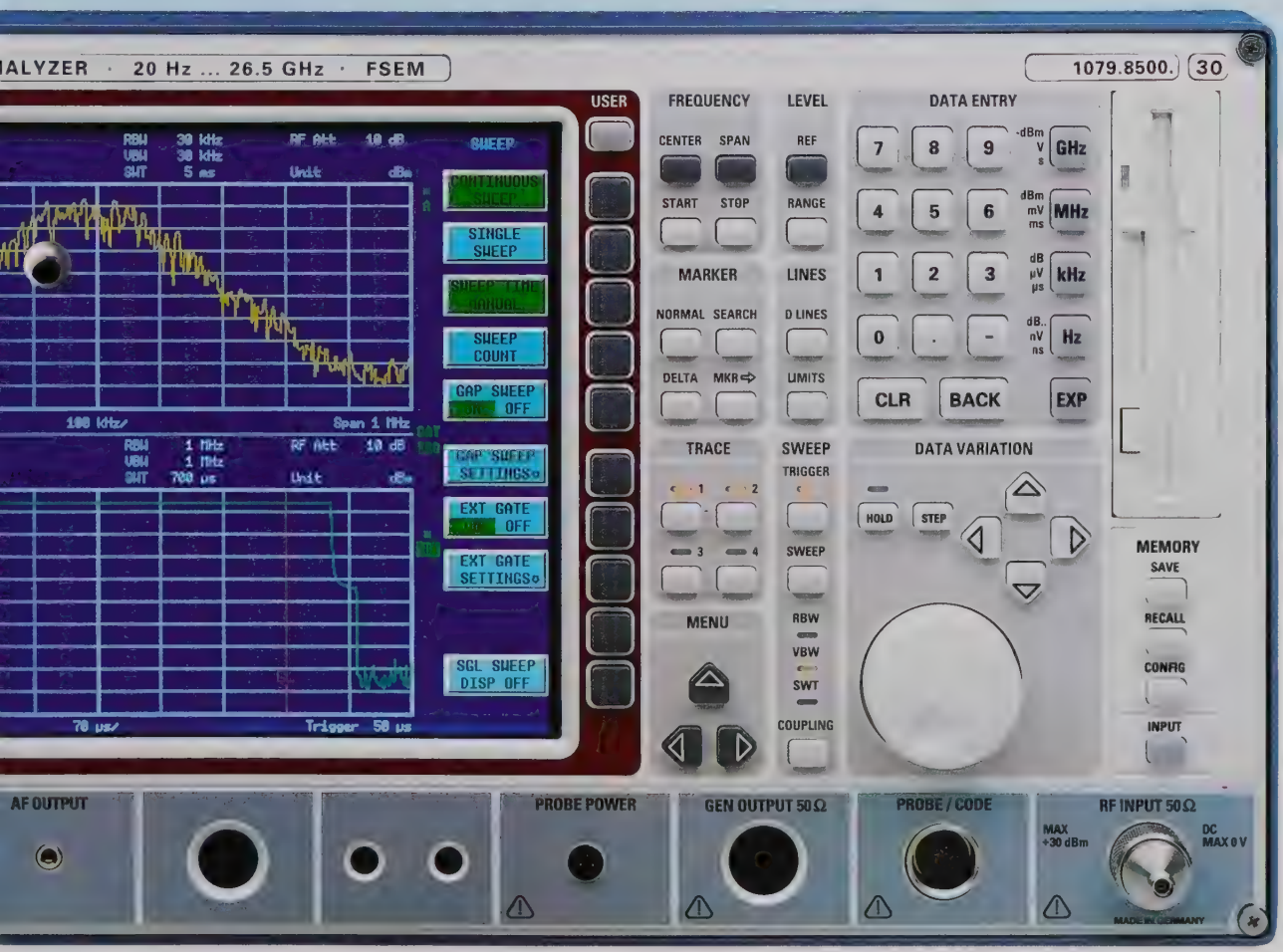
Your decision for Spectrum Analyzer FSE is a decision for a safe investment.

A triple record holder in speed

FSE breaks the speed record in three fields:

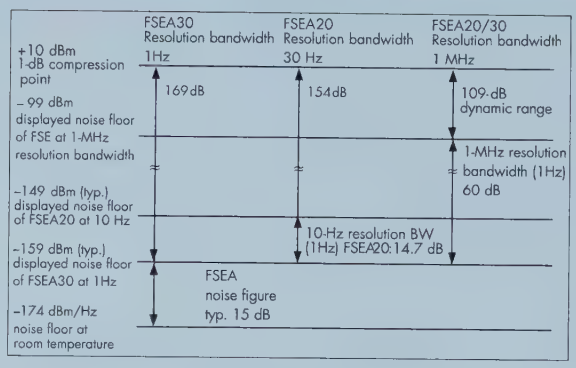
- FSE features a minimum full-span sweep time of 5 ms (for FSEA and FSEB) with a fully synchronized sweep. This means that added speed is not at the expense of frequency accuracy but even enhances it.
- The shortest zero-span sweep time is 1 µs (100 ns/div) – ideal for high-resolution measurements on pulse edges.
- Up to 25 sweeps per second is an optimal prerequisite for rapid and easy alignments and for applications in production.

With its high measurement speed and great ease of operation, FSE will solve even highly complex measurement tasks in the shortest possible time.

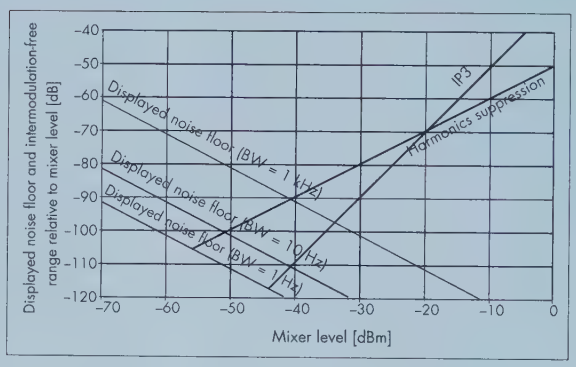


Spectrum Analyzer
FSEM30

The features in detail



Dynamic range, noise and 1-dB compression point for models of Spectrum Analyzer FSE



Dynamic range, noise, 3rd-order intercept point

Tops in dynamic range

FSE is outstanding for its extremely low noise floor without any impairment to the dynamic range at large signal levels. This can be seen, for example, from the 1-dB compression point of +10 dBm, which yields a dynamic range of 109 dB even at a resolution bandwidth of 1 MHz, allowing GSM and DECT power ramps to be determined.

The extremely wide intermodulation-free dynamic range of typ. 116 dB (models .30) and 105 dB (models .20) not only ensures reliable measurements on highly linear amplifiers, it also enables detailed analysis of complex broadband signals.

Taking as a figure of merit of an analyzer the difference between its 3rd-order intercept point and its noise figure, FSE can offer a value of around 0 dB. Put this figure to the test.

From AF to microwave

FSEM enables you to utilize the excellent characteristics of the 3.5 and 7 GHz basic models in the microwave range up to 26.5 GHz:

- Continuous full-span sweep
- Fundamental mixing, low noise floor as well as a wide dynamic range even up to 26.5 GHz make for extremely convenient and fast analysis in the microwave range
- Fully synchronized sweep with high frequency accuracy even for FULL SPAN (26.5 GHz)
- RF input adapter for N or 3.5-mm male and female connectors

Unattained measuring convenience

FSE makes measuring easy for you, offering a large number of convenient test functions:

- 4 markers, 4 delta markers
- Marker functions for the direct measurement of
  - phase noise and noise power density (/Hz)
  - NEXT MIN/PEAK, NEXT MIN/PEAK RIGHT, NEXT MIN/PEAK LEFT
- Measurement of channel power, adjacent channel power and occupied bandwidth
- Frequency counter with selectable resolution
- LOW NOISE, NORMAL and LOW DISTORTION modes to cater for low-intermodulation and low-noise operation
- One-button hardcopy on printer or plotter in background operation

Model	Frequency range	Display	Log level display to	Resolution bandwidths	Low phase noise and OCXO	1-Hz resolution bandwidth
FSEA20	9 kHz to 3.5 GHz	Mono	95 dB	10 Hz to 10 MHz, 4-pole filters	❍	❍
FSEA30	20 Hz to 3.5 GHz	Colour	105 dB	1 Hz to 10 MHz, 5-pole filters	●	●
FSEB20	9 kHz to 7 GHz	Mono	95 dB	10 Hz to 10 MHz, 4-pole filters	❍	❍
FSEB30	20 Hz to 7 GHz	Colour	105 dB	1 Hz to 10 MHz, 5-pole filters	●	●
FSEM20	9 kHz to 26.5 GHz	Mono	95 dB	10 Hz to 10 MHz, 4-pole filters	❍	❍
FSEM30	20 Hz to 26.5 GHz	Colour	105 dB	1 Hz to 10 MHz, 5-pole filters	●	●

Differences between FSE models in detail ● Incorporated in basic model ❍ Can be retrofitted

- Simultaneous measurement of four active traces
- Selectable colour setup (models .30) or with option FSE-B1 (models .20)
- Numerous level and frequency lines
- Split screen with independent windows
- Quasi-analog display

Frequency accuracy – to the point

Tuning on FSE is absolutely synchronous to the reference frequency for each span including full span. This means that every point on the frequency axis is determined with the accuracy of the internal reference frequency. Thus, when reducing the span for detailed signal analysis, the tiresome readjustment of the center frequency is no longer needed.

FSE in its basic configuration includes an AM/FM demodulator. Unknown signals can thus easily be identified via headphones or the built-in loudspeaker. Modulation measurements are possible using the optional Vector Signal Analyzer FSE-B7.

Limit lines facilitate checking if results are within predefined tolerances. Virtually any number of limit lines can be defined with high accuracy by means of 50 points to meet even the most exacting requirements.

Operation – as you like it

Like Spectrum Analyzer FSA from Rohde&Schwarz, which is known for its great user-friendliness, FSE features a combination of hardkeys (fixed functions) and softkeys (menu functions). Upon pressing a hardkey, the associated menu is called and an input field is opened. This means very fast, hardkey-oriented handling of the main functions such as frequency (center, start and stop), span, sweep time, reference level, etc without the need to operate any softkey.

The full operating convenience based on a wide variety of evaluation routines and marker functions can be accessed via the menus. Complicated tree structures are a thing of the past with FSE. Instead, the menus are of lateral structure and use fixed control keys (left, right, up).

FSEA 30, FSEB 30 and FSEM 30 are equipped with a large 9.5" (24 cm) TFT colour display with VGA resolution (640 x 480 pixels). All essential parameters and results can be seen at a glance. All test data, scale factors and setting parameters are logically arranged and thus easy to find. Setups, traces and graticules displayed in colour make for error-free analysis of complex results.

The features in detail

Designation	Type	Use	Functions
Noise measurement software	FSE-K3	Noise figure measurements	• Measurement of noise figure and temperature to Y-factor method • 2nd-stage correction • Conversion measurements • Frequency range same as basic unit, starting from 100 kHz • Editor for ENR tables • Compensation of isolator and cable losses
GSM test software	FSE-K10	Mobile radio, transmitter measurements to GSM standards	• Power ramp and power template • Spectrum due to modulation/switching • Spurious emissions • Mean carrier power

Application software for Spectrum Analyzer FSE with Computer Function FSE-B15

Quality management at Rohde&Schwarz

Lasting customer satisfaction is our primary objective. The quality management system of Rohde&Schwarz meets the requirements of ISO 9001 and encompasses largely all fields of activity of the company.

Certified Quality System
ISO 9001
DQS REG. NO 1954-02

The USER key allows operation to be tailored to your specific requirements. With this key, you can compile the functions mainly needed for your measurement tasks, doing away with frequent menu changes and speeding up measurements on the whole.

Test results – perfectly documented

FSE affords uncomplicated logging of results. It supports a wide variety of printers or plotters:

- FX-80 and compatibles
- Printers with HP-PCL
- HP-GL
- Postscript

The printer/plotter interface is freely selectable. Printers, for example, can be addressed via the Centronics interface or via the IEC/IEEE bus. Print files can not only be output via an interface but also be stored on diskette or the internal harddisk. With PCX, WMF and HP-GL print formats being available, there is no problem in further processing print files in standard text processing systems. Using Computer Function FSE-B15, it is particularly easy to generate test reports and integrate the results. Texts can then be processed under Windows on FSE itself, there is no need for an external PC.

FSE works as a PC

The optional Computer Function FSE-B15 provides a further VGA card, a memory extension to 16 Mbyte, a serial mouse and a keyboard. FSE-B15 is available in English and German and is supplied installed in FSE when ordered together with the unit. The option opens up the world of Windows applications, eg statistics programs, spreadsheet analysis and Visual Basic. FSE can even be linked to a network using the optional Ethernet Interface FSE-B16.

Complete setups, traces, limit lines and macros can be stored non-volatile on the internal harddisk or on diskette with the built-in 1.44-Mbyte drive.

FSE in automatic test systems

FSE is ideal for use in automatic test systems, affording not only fast processing of results but also an IEC/IEEE-bus command set conforming to SCPI.

Moreover, with optional Computer Function FSE-B15 and a second IEC/IEEE-bus card (option FSE-B17), FSE can be used as a controller for test systems, thus eliminating the need for further units and saving space in the system cabinet.

Rear of Spectrum Analyzer FSE

Low overall costs

In designing FSE, special emphasis was placed on keeping after-sales costs to a minimum:

- Consequently designed for maximum reliability
- Temperature-controlled blowers
- Calibration interval up to 2 years
- Built-in calibration routines
- Elaborate selftest routines
- Modular design

Selftest – the built-in diagnostic system

The instrument selftest rapidly locates any faults down to module level. Defective modules can be replaced nearly without adjustments or extra test equipment being required. This in conjunction with the quick spare parts service from Rohde&Schwarz reduces any repair or down-time costs that might arise. The low operating costs go easy on your budget.

Calibration routines

Built-in calibration routines ensure that FSE remains within defined tolerances and thus maintains its accuracy of measurement. The routines are not performed automatically by the instrument but can be started by the user, thus avoiding ongoing measurements to be interrupted.

The results of calibration routines are output by FSE in the form of comprehensive correction tables. Comparing these tables over an extended period of time, the user can detect changes early and take corrective steps in time. This enhances confidence in the unit's reliability and measurement accuracy.

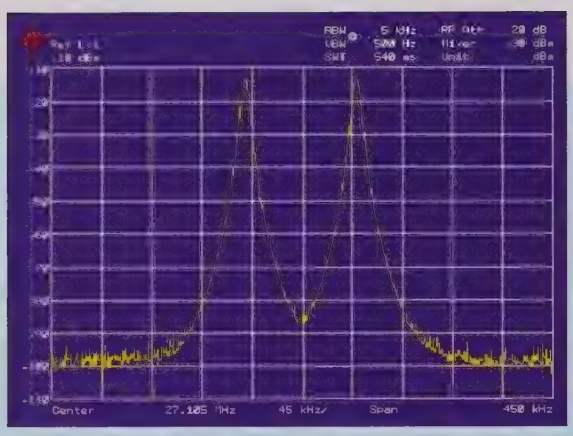
A particular asset in system applications is the internally selectable, high-precision level calibration source, which reduces the number of cables required.

Modular design – easy retrofitting of options

The easy concept for fitting the most important options, ie Vector Signal Analyzer, Low Phase Noise and OCXO and 7-GHz Frequency Extension, and the easy, adjustment-free incorporation of the remaining options make it possible to retrofit the instrument with a minimum of down times or installation costs being involved.

Applications

General-purpose RF measurements



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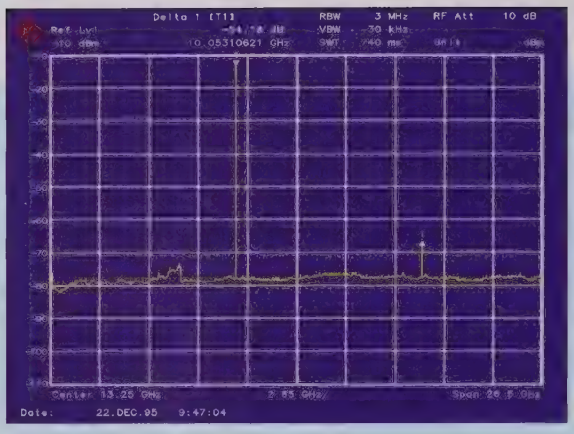

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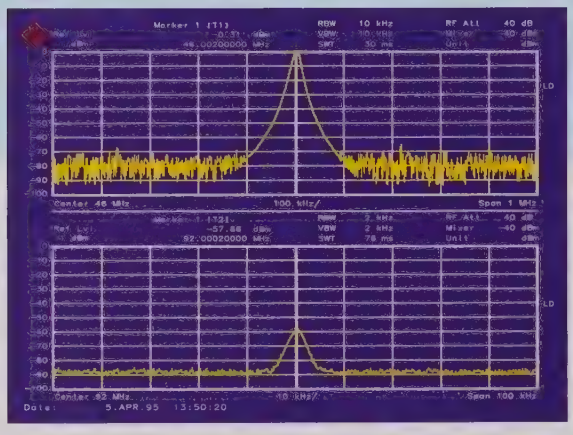

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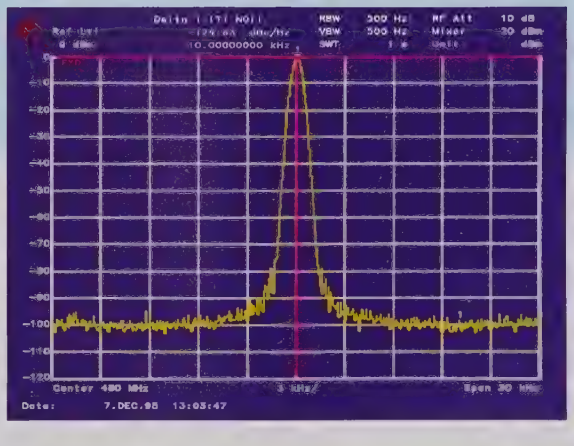

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Two-tone measurements (1)
FSE facilitates intermodulation measurements with its wide intermodulation-free dynamic range, which reduces measurement errors. This feature is enhanced by the LOW DISTORTION mode, which ensures optimum RF attenuation. Evaluation of results is rapid and easy by means of markers and delta markers.

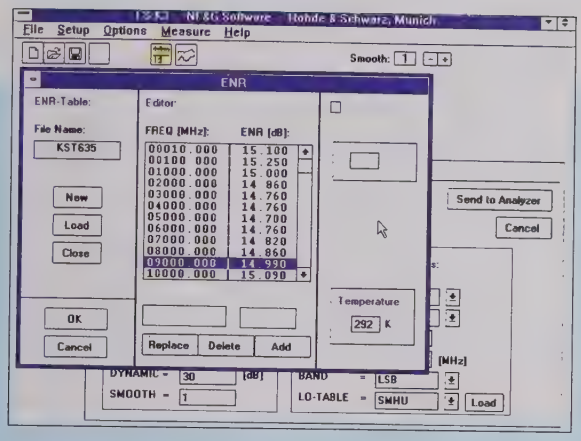
Harmonics measurements with split screen (2)
The split-screen function has been provided for the convenient analysis of results. In harmonics measurements, for example, the fundamental and the first harmonic can be displayed simultaneously with high resolution.

Low noise floor even in the microwave range (3)

Thanks to fundamental mixing FSEM features the same constantly low noise floor as an RF analyzer up to 26.5 GHz. As a consequence, FSEM offers not only a wide dynamic range, but also a considerably increased speed for measuring small signals in the microwave range: Larger resolution bandwidths and high sensitivity reduce sweep time while maintaining the S/N ratio. This is of great advantage when measuring spurious and harmonics alike.

FSE phase noise as a function of carrier spacing (4)
With a phase noise of better than –123 dBc/Hz at 10 kHz from the carrier, the synthesizer incorporated in FSEA 30 is ideal for measuring the phase noise of oscillators or the adjacent-channel power of radio equipment. FSEA 20, on the other hand, is ideal for applications where phase noise in the vicinity of the carrier plays a less important role. Thanks to the modular design of the instrument, FSEA 20, FSEB 20 and FSEM 20 can easily be retrofitted with the synthesizers of FSEA 30, FSEB 30 or FSEM 30.

Noise figure measurements



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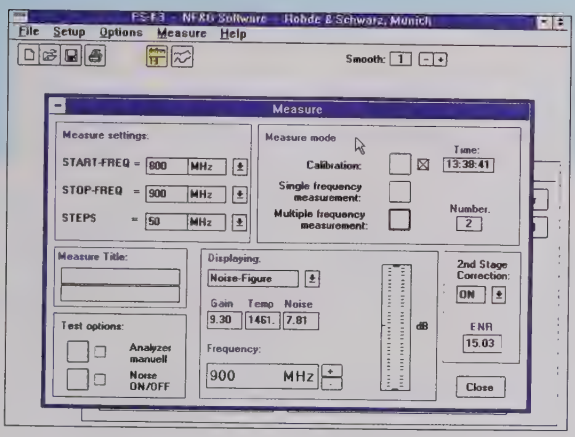

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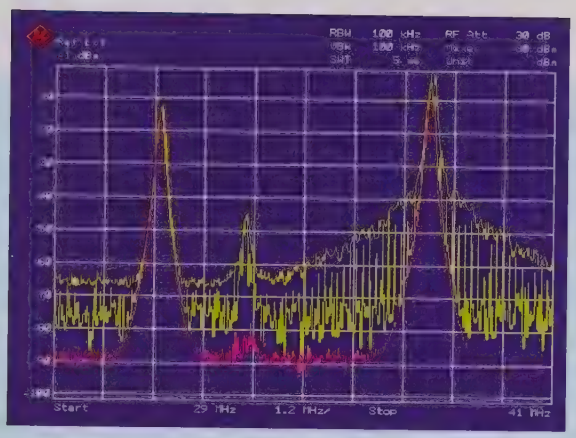
TV measurements



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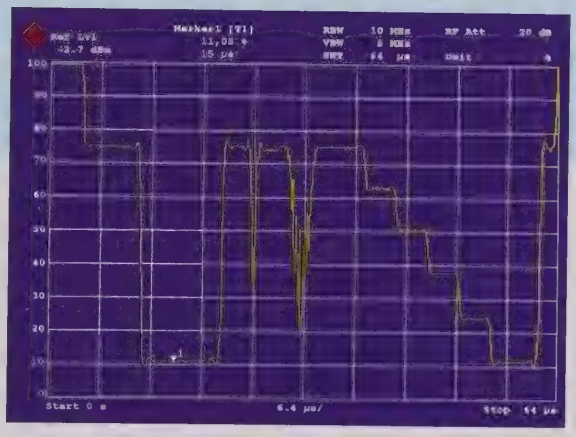


4

Noise Measurement Software FSE-K3 (1 and 2)

FSE-K3 turns your FSE into a noise-figure/gain measurement system offering the advantages of an analyzer:

- From the large number of resolution bandwidths available, you can choose the right one for your application, even for measurements on narrowband EUTs
- With ambiguous results, you can check your test system for EM pick-up or nonharmonics
- The lower frequency limit of 100 kHz enables noise-figure measurements even in the short-wave range

With an upper frequency limit of 3.5 GHz, FSEA is already equipped to handle the latest IF frequency ranges of up to 2.05 and 2.7 GHz used by Sat TV low-noise block downconverters. Use of FSEB extends the frequency range to 7 GHz.

To perform noise figure measurements with FSE, the following is required in addition to the analyzer:

- Noise Measurement Software FSE-K3
- PC with Windows-compatible IEC/IEEE-bus card or, simply, Computer Function FSE-B15 for FSE
- Noise source (eg from Noise Com – we shall be glad to advise you)
- Preamplifier, eg ESV-Z3 from R&S.

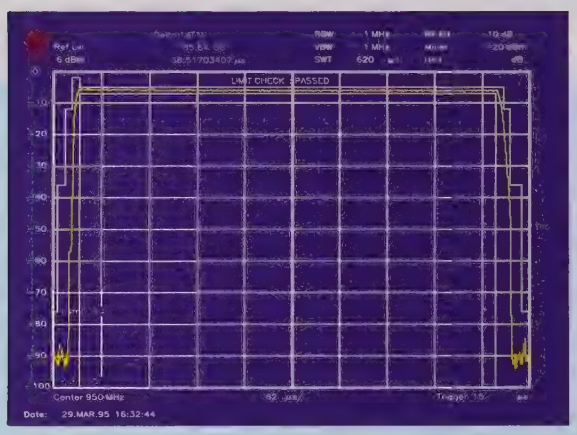
TV signal in zero span and TV trigger (3 and 4)

With a maximum resolution bandwidth of 10 MHz, implemented with the optional TV Demodulator FSE-B3 with TV trigger, and an extremely fast zero-span sweep time of 1 µs, FSE fulfills all requirements for the analysis of TV signals. Frame-frequency and line trigger, trigger delay and gap sweep allow the convenient selection and analysis of individual lines.

Moreover, the quasi-analog display provides luminance-signal information, enabling the detection of intermodulation products in the TV spectrum.

Applications

Mobile radio – digital and analog



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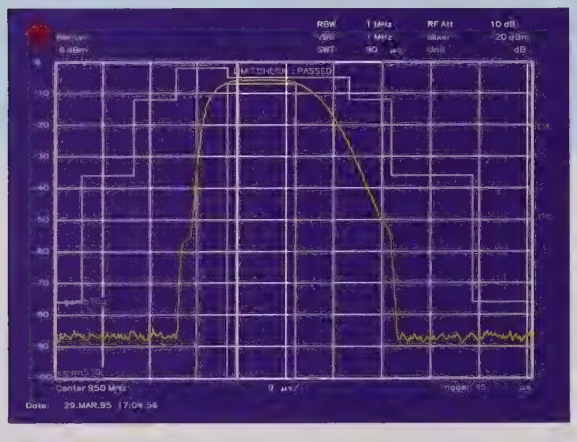

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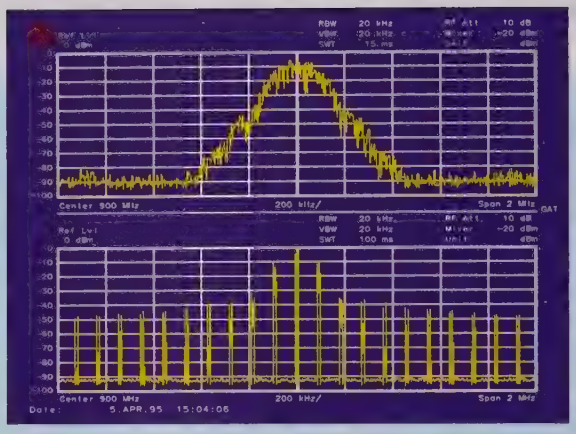

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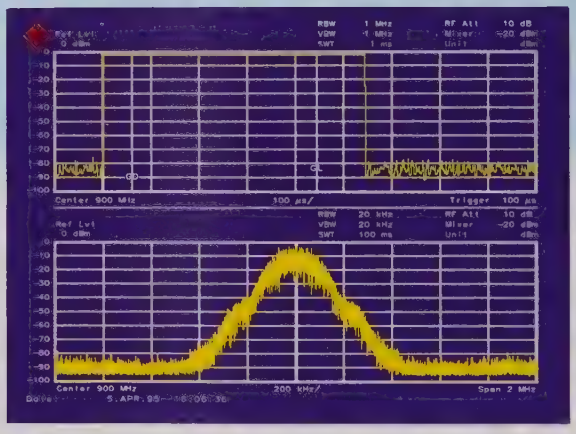


4

RF power trigger replaces external trigger (no illustration)

An internal broadband level detector (center frequency ±50 MHz) with a fixed switching threshold of approx. –4 dBm at the first mixer is used as a trigger source. With this detector it is possible, for example, to perform "Spectrum due to switching" and "Spectrum due to modulation" measurements to GSM specifications without an external trigger. Likewise, the detector replaces the external trigger needed in the gated sweep mode.

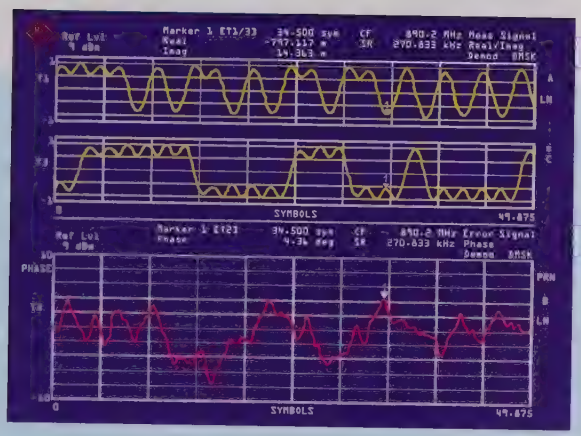
Gap sweep: simultaneous measurement of pulse rise and fall times with high time resolution (1 and 2)

The fast sweep time of 100 ns/div as well as the gap sweep and pretrigger functions of Spectrum Analyzer FSE make it possible to measure the rise and fall times of an RF pulse simultaneously and with high time resolution. The center of the pulse, which is of no interest, is blanked. Even at a resolution bandwidth of 1 MHz FSE offers a dynamic range of over 80 dB thanks to the high 1-dB compression point of +10 dBm.

Gated sweep (3 and 4)

The gated sweep function is indispensable for analyzing TDMA signals used in modern communication systems. With this function, the spectrum of burst signals can be investigated without any interference being caused by switching the signals on and off. The selected gate time determines over what interval a pulse is to be analyzed. Selection of the gate time is very easy and convenient in the time domain display (zero span) of the pulse.

Vector signal analysis



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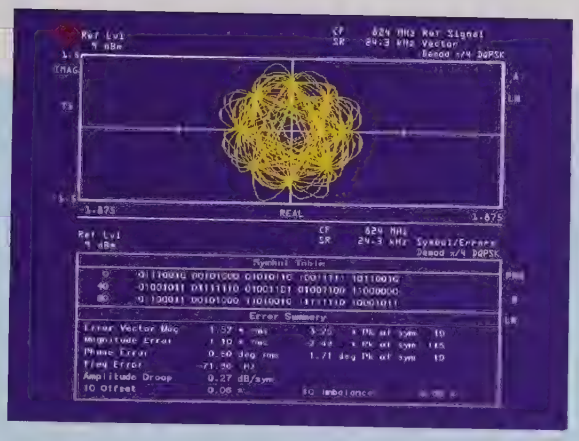

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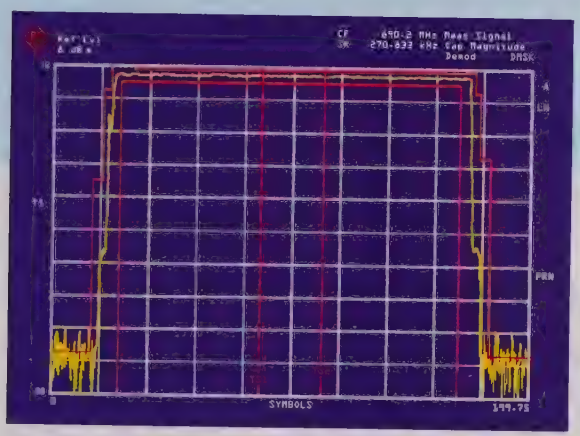


2

1 I/Q signal and phase error measurements over 50 symbols of a GSM mobile

2 Measurement of GSM power ramps to standards with high-precision time reference through synchronization to mid-amble

3 Measurement of modulation error of π/4-DQPSK signals (NADC)

Universal analysis of digital signals

Spectrum Analyzer FSE in conjunction with the optional Vector Signal Analyzer FSE-B7 is ideal for demodulating and measuring digitally modulated signals with frequencies up to 3.5 GHz, 7 GHz or 26.5 GHz. This universal tool offers a wide variety of settings:

- Demodulation of all common mobile-radio signals
- Freely selectable symbol rates
- Type of filter
- Roll-off factor or BT product of filter
- Synchronization bit sequences
- Predefined, application-specific settings for all common standards, eg GSM, NADC etc

Versatile display of results

- In-phase and quadrature signals
- Magnitude and phase
- Vector and constellation diagrams
- Eye and trellis diagrams
- Sum fault: amplitude, frequency, phase, vector

Power ramp measurements

To perform power ramp measurements on TDMA systems such as GSM or DECT in line with standards, reference must be made to synchronization sequences (pre- or mid-amble) in order to establish a time reference. Making such measurements to standard is not possible using conventional analyzers – it is no problem with FSE!

Accurate AM, FM and φM measurements

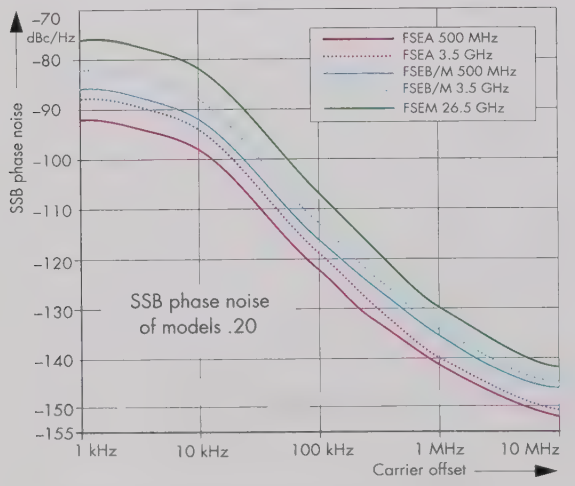
Featuring high-accuracy measurement of the modulation depth and frequency deviation coupled with the display of demodulated signals in the time domain, FSE not only enables testing of analog and dual-mode radio equipment but also the determination of fast transient response in frequency and amplitude (see separate data sheet Vector Signal Analyzer Option FSE-B7, order number 757.2167).

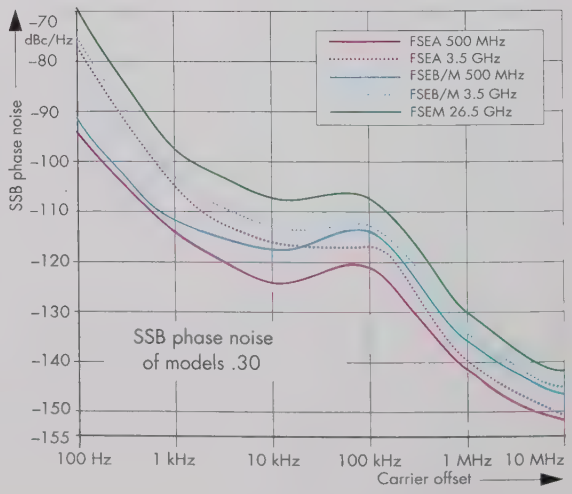
Spectrum Analyzer FSE and vector signal analyzer option provide universal test capabilities in one unit.

Specifications

	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30
Specifications are guaranteed under the following conditions: 5 minutes warmup time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and total calibration performed. Data without tolerances: approx. value only. Data designated "nominal" apply to design parameters and are not tested.						
Frequency						
Frequency range	9 kHz to 3.5 GHz	20 Hz to 3.5 GHz	9 kHz to 7 GHz	20 Hz to 7 GHz	9 kHz to 26.5 GHz	20 Hz to 26.5 GHz
Frequency resolution	0.01 Hz					
Frequency axis	linear or logarithmic					
Reference frequency						
Internal, nominal						
Aging, after 30 days operation	1×10^{-6}/year	1×10^{-9}/day, 2×10^{-7}/year	1×10^{-6}/year	1×10^{-9}/day, 2×10^{-7}/year	1×10^{-6}/year	1×10^{-9}/day 2×10^{-7}/year
Temperature drift (0 to 50°C)	1×10^{-6}	5×10^{-8}	1×10^{-6}	5×10^{-8}	1×10^{-6}	5×10^{-8}
Total error	2.5×10^{-6}/year	2.5×10^{-7}/year	2.5×10^{-6}/year	2.5×10^{-7}/year	2.5×10^{-6}/year	2.5×10^{-7}/year
With option FSE-B4						
Aging, after 30 days operation	1×10^{-9}/day, 2×10^{-7}/year	–	1×10^{-9}/day, 2×10^{-7}/year	–	1×10^{-9}/day 2×10^{-7}/year	–
Temperature drift (0 to 50 °C)	5×10^{-8}	–	5×10^{-8}	–	5×10^{-8}	–
Total error	2.5×10^{-7}/year	–	2.5×10^{-7}/year	–	2.5×10^{-7}/year	–
External	10 MHz or n × 1 MHz, n=1 to 16					
Frequency display	with marker					
Resolution	0.1 Hz to 10 kHz (dependent on span)					
Error (Sweeptime >3×Auto sweeptime)	±(marker frequency × reference error + 0.5% × span + 10% × resolution bandwidth + 10 Hz + 1/2 (last digit))					
Frequency counter	measures the marker frequency					
Resolution	0.1 Hz to 10 kHz (selectable)					
Count accuracy (S/N >25 dB)	±(frequency × reference error + 10 Hz + 1/2 (last digit))					
Display range for frequency axis	0 Hz, 10 Hz to full span					
Resolution/Error of display range	0.1 Hz/1%					
Spectral purity SSB phase noise, RF frequency ≤500 MHz,	For f>500 MHz see diagrams below					
carrier offset 100 Hz	–	<–87 dBc/Hz	–	<–81 dBc/Hz	–	<–81 dBc/Hz
1 kHz	<–85 dBc/Hz	<–107 dBc/Hz	<–79 dBc/Hz	<–100 dBc/Hz	<–79 dBc/Hz	<–100 dBc/Hz
10 kHz	<–96 dBc/Hz	<–120 dBc/Hz	<–90 dBc/Hz	<–114 dBc/Hz	<–90 dBc/Hz	<–114 dBc/Hz
100 kHz[1]	<–119 dBc/Hz	<–117 dBc/Hz	<–113 dBc/Hz	<–111 dBc/Hz	<–113 dBc/Hz	<–111 dBc/Hz
1 MHz[1]	<–135 dBc/Hz	<–135 dBc/Hz	<–129 dBc/Hz	<–129 dBc/Hz	<–129 dBc/Hz	<–129 dBc/Hz
With option FSE-B4	For models .20 with option FSE-B4 values of models .30 apply					
Sweep time	1 µs to 1000 s in 5-% steps					
Display range 0 Hz	5 ms to 1000 s in steps ≤10 %					
Display range ≥10 Hz	1%					
Error	>20 updates/s with 1 trace, >15 updates/s with 2 traces					
Picture refresh rate (Span ≤7 GHz)	50 ns (20-MHz A/D converter)					
Sampling rate	500					
Number of pixels	with marker and cursor lines					
Time measurement	50 ns					
Resolution	free run, single, line, video, gated, delayed, external					
Sweep trigger	additionally pretrigger, posttrigger, trigger delay					
Zero span						

[1]) Valid for span >100 kHz.





Specifications

	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30
Resolution bandwidths						
3-dB bandwidths	10 Hz to 10 MHz in 1/2/3/5 steps	1 Hz to10 MHz in 1/2/3/5 steps	10 Hz to 10 MHz in 1/2/3/5 steps	1 Hz to 10 MHz in1/2/3/5 steps	10 Hz to 10 MHz in 1/2/3/5 steps	1 Hz to 10 MHz in1/2/3/5 steps
Bandwidth error						
≤3 MHz	<10%					
5 MHz	<15%					
10 MHz	+25%, –10%					
Shape factor 60:3 dB						
<1 kHz	<6					
1 kHz to 2 MHz	<15	<12	<15	<12	<15	<12
>2 MHz	<7					
Video bandwidths	1 Hz to 10 MHz in 1/2/3/5 steps					
Level						
Display range	noise floor displayed to 30 dBm					
Maximum input level						
RF attenuation 0 dB						
DC voltage	0 V					
CW RF power	20 dBm (=0.3 W)					
Pulse spectral density	97 dBµV/MHz					
RF attenuation ≥10 dB						
DC voltage	0 V					
CW RF power	30 dBm (=1 W)					
Max. pulse voltage	150 V				50 V	
Max. pulse energy (10 µs)	1 mWs				0.5 mWs	
1-dB compression of input mixer (0 dB RF attenuation)	+10 dBm nominal					
Displayed averaged noise floor (0 dB RF attenuation, RBW=10 Hz, VBW=1 Hz, 20 averages, trace average, span 0 Hz, termination 50 Ω) frequency:						
20 Hz	–	<–80 dBm	–	<–74 dBm	–	<–74 dBm
1 kHz	–	<–110 dBm	–	<–104 dBm	–	<–104 dBm
10 kHz	<–90 dBm	<–125 dBm	<–84 dBm	<–119 dBm	<–84 dBm	<–119 dBm
100 kHz	<–110 dBm	<–135 dBm	<–104 dBm	<–129 dBm	<–104 dBm	<–129 dBm
1 MHz	<–130 dBm, typ. –135 dBm	<–145 dBm, typ. –150 dBm	<–125 dBm, typ. –130 dBm	<–142 dBm, typ. –145 dBm	<–124 dBm, typ. –129 dBm	<–142 dBm, typ. –145 dBm
10 MHz to 3.5/6 GHz	<–145 dBm, typ. –150 dBm	<–145 dBm, typ. –150 dBm	<–142 dBm, typ. –147 dBm	<–142 dBm, typ. <–147 dBm	<–138 dBm, typ. –140 dBm	
6 to 7 GHz	–	–	<–139 dBm	<–139 dBm	<–135 dBm, typ. –138 dBm	
7 to 18 GHz	–	–	–	–	<–138 dBm, typ. –140 dBm	
18 to 26.5 GHz	–	–	–	–	<–135 dBm, typ. –138 dBm	
Max. dynamic range	**10 Hz bandwidth**	**1 Hz bandwidth**	**10 Hz bandwidth**	**1 Hz bandwidth**	**10 Hz bandwidth**	**1 Hz bandwidth**
Displayed noise floor at 1-dB compres.	155 dB	165 dB	152 dB	162 dB	150 dB	160 dB
Max. harmonics suppres., f >50 MHz	>90 dB					
Max. intermodulation-free range						
50 MHz to 3.5 GHz (nominal)	105 dB	115 dB	–	–	–	–
150 MHz to 7/26.5 GHz (nominal)	–	–	105 dB	115 dB	103 dB	112 dB
Intermodulation						
3rd-order intercept point (T.O.I.), Δf >5 × resolution BW or >10 kHz	≥12 dBm, typ. 15 dBm for f >50 MHz		≥12 dBm, typ. 15 dBm for f >150 MHz			
Intermodulation-free range at –40 dBm mixer level	105 dB					
Intercept point k2	>25, typ. >40 dBm for f <50 MHz, >45 dBm, typ. >50 dBm for f >50 MHz		>25 dBm for f <150 MHz, >35 dBm typ. >40 dBm for f >150 MHz, >45 dBm typ.			
Immunity to interference						
Image frequency	>75 dB	>80, typ. >90 dB	>80, typ. >90 dB			
Intermediate frequency	>80 dB	>100 dB	>75 dB			
Spurious response (f >1 MHz, without input signal, 0 dB attenuation)						
Span <30 MHz	<–100 dBm	<–110 dBm	<–100 dBm	<–110 dBm	<–100 dBm	<–110 dBm
Span ≥30 MHz	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm
f_{in} = 25.175 MHz	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm
f_{in} = 60 MHz	<–100 dBm	<–110 dBm	<–100 dBm	<–100 dBm	<–100 dBm	<–100 dBm

Specifications

	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30
Level display						
Screen	10 × 10 subdivisions					
Trace	500 × 400 pixels (with one diagram displayed)					
Log level axis	10 to 200 dB, in steps of 10 dB					
Linear level axis	10% of reference level per level division, 10 divisions					
Setting range of reference level						
Log level display	–130 to 30 dBm, in steps of 0.1 dB					
Linear level display	7.0 nV to 7.07 V in steps of 1%					
Units of level axis	dBm, dBµV, dBµA, dBpW (log level display) mV, µV, mA, µA, pW, nW (linear level display)					
Level measurement error –40 dBm, RF Attenuation 20 dB, Ref. Lev. –15 dB, RBW 5 kHz	**The values are guaranteed for bandwidth from 10 Hz to 30 kHz and 100 kHz to 10 MHz**					
Absolute error at 120 MHz	<0.3 dB					
Freq. response (10 dB RF atten.)						
<1 GHz	<0.5 dB					
1 to 3,5/7 GHz	<1 dB					
7 to 18 GHz	–	–	–	–	<2 dB[1])	
18 to 26.5 GHz	–	–	–	–	<2.5 dB[1])	
Attenuator error	<0.3 dB				<0.4 dB + 1.3 % of attenuation	
IF gain error	<0.2 dB (typ. 0.1 dB)					
Linearity error						
Log level display						
(RBW ≥1 kHz, analogue, S/N >15 dB)						
0 to –50 dB	<0.3 dB					
–50 to –70 dB	<0.5 dB					
–70 to –80 dB	<1 dB	–	<1 dB	–	<1dB	–
–70 to –95 dB	–	<1 dB	–	<1 dB	–	<1 dB
(RBW ≤ 1 kHz, digital, S/N >15 dB)						
0 to –100 dB	<0.3 dB nominal					
Linear level display	5% of ref level					
Bandwidth switching error						
1 Hz to 30 kHz/100 to 300 kHz	<0,2 dB/<0.2 dB					
1 to 10 MHz	<0.3 dB					
Total measurement error (0 to –50 dB, S/N >15 dB)						
<1 GHz	<1 dB					
1 to 3.5/7 GHz	<1.5 dB					
7 to 18 GHz	–	–	–	–	<2 dB[1])	
18 to 26.5 GHz	–	–	–	–	<2.5 dB[1])	
Pulse amplitude error (single pulses)						
Bandwidth <1 MHz/≥1 MHz	<0.5 dB, nominal/<2 dB, nominal					
Trigger functions						
Trigger	free run, line, video, RF, external					
Delayed sweep						
Trigger source	free run, line, video, RF, external					
Delay time	100 ns to 10 s, resolution 1 µs min. (or 1 % of delay time)					
Error of delay time	±(1 µs + (0.1% × delay time))					
Delayed sweep time	2 µs to 1000 s					
Gated sweep						
Trigger source	external, RF					
Gate delay	1 µs to 100 s					
Gate length	1 µs to 100 s, resolution min. 1 µs or 1 %					
Error of gate length	±(1 µs + (0.05% × gate length))					
Gap sweep (Span = 0 Hz)						
Trigger source	free run, line, video, RF, external					
Pretrigger	1 µs to 100 s, 500 ns resolution, dependent on sweep time					
Trigger to gaptime	1 µs to 100 s, 500 ns resolution, dependent on sweep time					
Gap length	1 µs to 100 s, 500 ns resolution					
Demodulation						
Modulation modes	AM and FM					
Audio output	loudspeaker and headphones output					
Marker stop time	100 ms to 60 s					
Squelch	adjustable by means of level line					

[1]) For RF frequencies >7 GHz: error after setting peaking function. For sweeptime <10 ms/GHz: additional error 1.5 dB

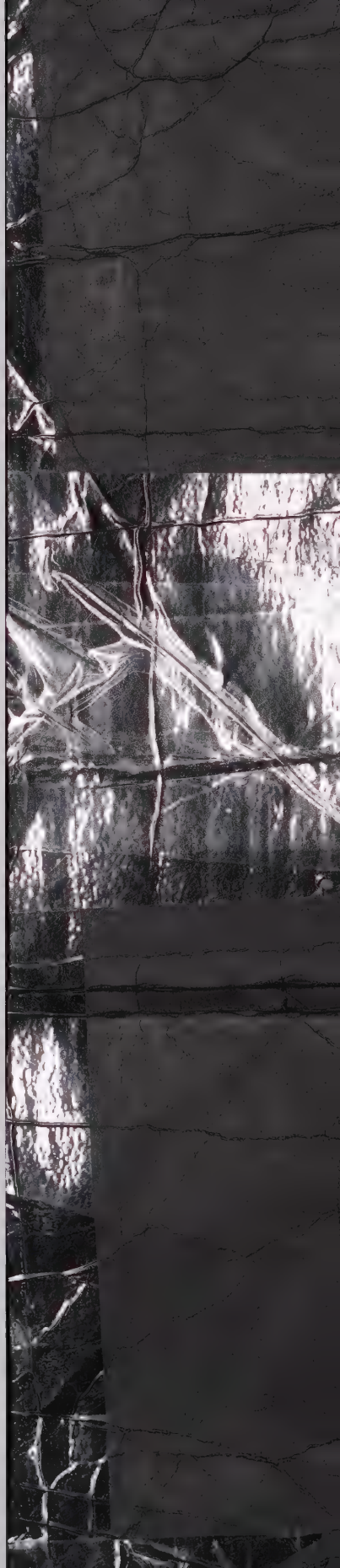
Specifications

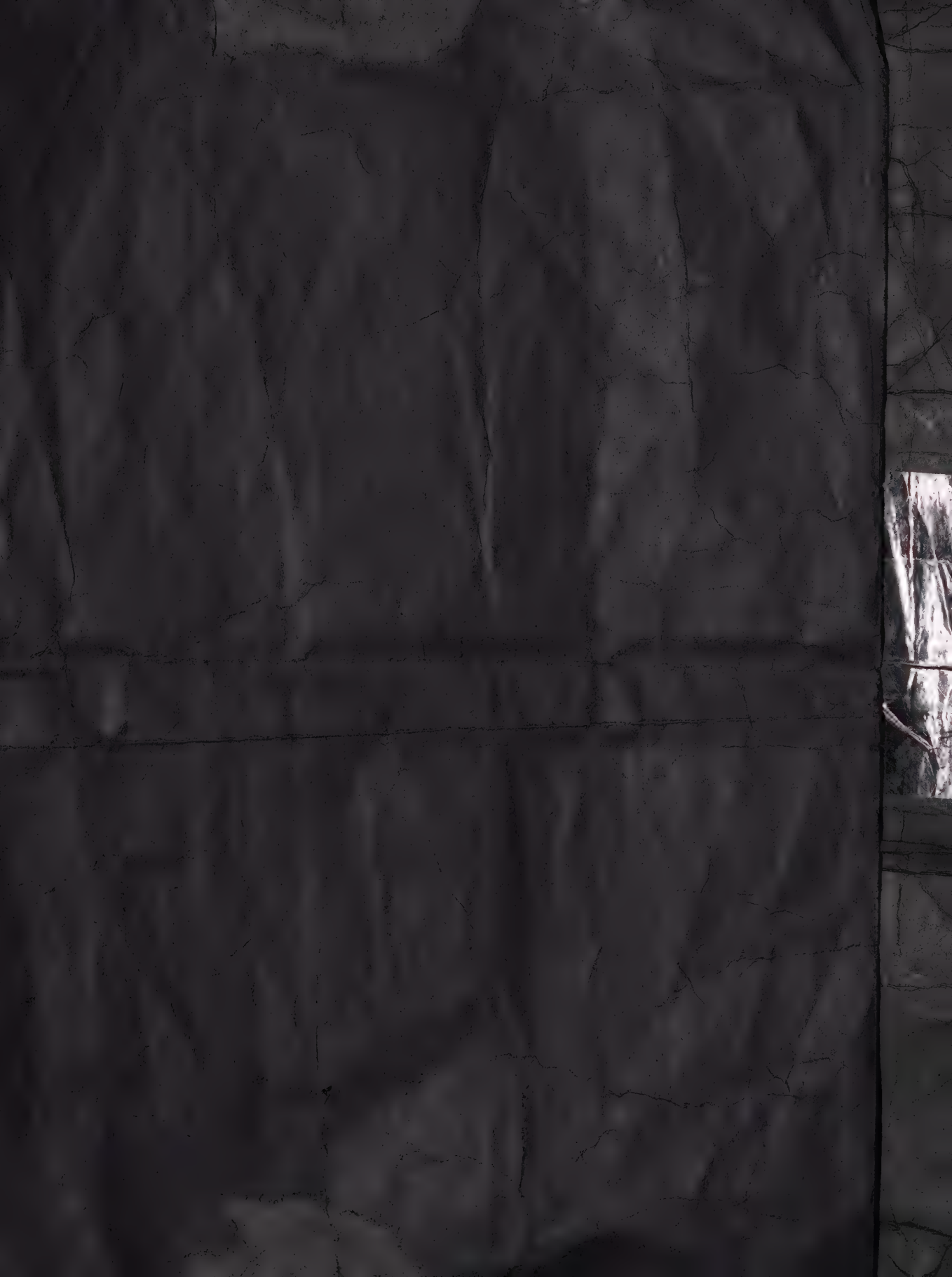
	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30
Inputs & outputs (front panel)						
RF input	N female, 50 Ω				adapter system, 50 Ω, N male and female, 3.5 mm male and female	
VSWR (RF attenuation >0 dB)						
f <3.5 GHz	<1.5					
f <7 GHz	–		<2.0			
f <26.5 GHz	–	–	–	–	<3	
Attenuator	0 to 70 dB, selectable in 10-dB steps					
Probe power supply	+15 V DC, –12.6 V DC and ground, max. 150 mA					
Power supply and coding connector for antennas etc (antenna code)	12-contact Tuchel connector					
Supply voltages	±10 V, max. 100 mA, ground					
AF output	Z_{out} = 10 Ω, jack plug					
Open-circuit voltage	adjustable up to 1.5 V					
Inputs & outputs (rear panel)						
IF 21.4 MHz	Z_{out} = 50 Ω, BNC female, bandwidth >1 kHz or resolution bandwidth					
Level	0 dBm at reference level, mixer level >–60 dBm					
Video output	Z_{out} = 50 Ω, BNC female					
Voltage (bandwidth ≥1 kHz	0 to 1 V, full scale (open-circuit voltage); log scaling					
Reference frequency						
Output, usable as input	BNC female					
Output frequency	10 MHz					
Level	10 dBm nominal					
Input	1 to 16 MHz, integer MHz					
Required level	>0 dBm from 50 Ω					
Sweep output	BNC female, 0 to 10 V, proportional to displayed frequency					
Noise source						
Power supply connect. f. noise source	BNC female, 0 and 28 V, switch-selected					
External trigger/gate input	BNC female, >10 kΩ					
Voltage	–5 to +5 V, adjustable					
IEC/IEEE-bus control	interface to IEC-625-2 (IEEE 488.2)					
Instruction set						
Connector	24-contact AmpSCPI 1994.0henol female					
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, C11					
Serial interface	RS-232-C (COM 1 and COM 2), 9-contact female connectors					
Mouse interface	PS/2 compatible					
Plotter	via IEC/IEEE bus or RS-232-C					
Plotter language	HP-GL					
Printer interface	parallel (Centronics compatible) or serial (RS-232-C)					
Keyboard connector	5-contact DIN female for MF-2 keyboard					
User interface	25-contact Cannon female					
Connector f. external monitor (VGA)	15-contact female					
General data						
Display	24-cm LC display (9.5"), optionally: 24-cm LC colour display (factory-fitted only)	24-cm LC colour display (9.5")	24-cm LC display (9.5"), optionally: 24-cm LC colour display (factory-fitted only)	24-cm LC colour display (9.5")	24-cm LC display (9.5"), optionally: 24-cm LC colour display (factory-fitted only)	24-cm LC colour display (9.5")
Resolution	640 × 480 pixels (VGA resolution)					
Mass memory	1.44 Mbyte 3 1/2" diskette (built-in disk drive), harddisk					
Operating temperature range						
Nominal temperature range	+5 to +40°C					
Limit temperature range	+0 to +50°C					
Storage temperature range	–40 to +70°C					
Climatic loading	+40°C at 95% relative humidity (IEC 68–2–3)					
Mechanical stress						
Sinusoidal vibration	5 to 150 Hz, max. 2 g at 55 Hz; 0.5 g from 55 to 150 Hz; to IEC 68-2-6, IEC 68-2-3, IEC 1010-1, MIL-T-28800D, class 5					
Random vibration	10 to 300 Hz, acceleration 1.2 g_{rms}					
Shock	40 g shock spectrum, to MIL-STD 810C and MIL-T-28800D, classes 3 and 5					
Recommended calibration interval	1 year (2 years for operation with external reference)					
RFI suppression	to EMC directive of EU (89/336/EEC) and German EMC law					
Power supply						
AC supply	100/120/230/240 V ±10%; 47 to 440 Hz, class of protection I to VDE 411					
Power consumption	170 VA	180 VA	185 VA	195 VA	220 VA	230 VA
Safety	to EN 61010-1					
Dimensions in mm (W x H x D)	435 × 236 × 460 (5 units of height)					435 × 236 × 570
Weight	21.5 kg	22.7 kg	21.8 kg	23.2 kg	23.8 kg	25.2 kg

Ordering information

Order designation	Type	Order No.
Spectrum Analyzer 9 kHz to 3.5 GHz	FSEA20	1065.6000.20
Spectrum Analyzer 20 Hz to 3.5 GHz	FSEA30	1065.6000.30
Spectrum Analyzer 9 kHz to 7 GHz	FSEB20	1066.3010.20
Spectrum Analyzer 20 Hz to 7 GHz	FSEB30	1066.3010.30
Spectrum Analyzer 9 kHz to 26.5 GHz	FSEM20	1080.1505.20
Spectrum Analyzer 20 Hz to 26.5 GHz	FSEM30	1079.8500.30
Accessories supplied Power cable, operating manual, spare fuses; FSEM: adapter 3.5 mm female (1021.0512.00) and N female (1021.0535.00)		
Options (also see tables on folding page)		
Colour Display for FSEA 20, FSEB 20 and FSEM 20 (factory-fitted only)	FSE-B1	1073.4990.02
7-GHz Frequency Extension for FSEA	FSE-B2	1073.5044.02
Low Phase Noise and OCXO (for models .20)	FSE-B4	1073.5396.02
Vector Signal Analyzer	FSE-B7	1066.4317.02
Computer Function for FSE, German (FSE-Z2 and PSA-Z2 included)	FSE-B15	1073.5696.02
Computer Function for FSE, English (FSE-Z2 and PSA-Z2 included)	FSE-B15	1073.5696.03
Ethernet Interface connector AUI, 15-contact	FSE-B16 [1]	1073.5973.02
Thin-wire, connector BNC	FSE-B16 [1]	1073.5973.03
2nd IEC/IEEE-bus Interface for FSE	FSE-B17 [1]	1066.4017.02
Software		
Noise Measurement Software	FSE-K3	1057.2996.02
GSM Test Software	FSE-K10	1057.3092.02
Recommended extras		
Service Kit	FSE-Z1	1066.3862.02
DC-Block, 5 to 7000 MHz	FSE-Z3	4010.3895.00
Service Manual	–	1065.6016.24
Headphones	–	0708.9010.00
German Keyboard	PSA-Z2	1007.3001.31
American Keyboard	PSA-Z2	1007.3001.02
PS/2 Mouse	FSE-Z2	1084.7043.02
Colour Monitor, 15", 230 V	PMC3	1082.6004.02
Printer, 24-pin printer head	PDN	0351.4512.04
IEC/IEEE-bus Cable, 1 m	PCK	0292.2013.10
IEC/IEEE-bus Cable, 2 m	PCK	0292.2013.20
19" Rack Adapter		
with front handles	ZZA-95	0396.4911.00
without front handles	ZZA-951	0396.9488.00
Set of Front Handles	ZZG-95	0396.5176.00
Transit Case	ZZK-954	1013.9395.00
Transit Case (FSEM only)	ZZK-955	1013.9408.00
Trolley	ZZK-1	1014.0510.00
Matching Pads, 75 Ω		
L section	RAM	0358.5414.02
Series resistor, 25 Ω	RAZ	0358.5714.02
Accessories for current, voltage and field-strength measurement	see accessories for Test Receiver ESS, data sheet PD 756.9768	
SWR Bridge, 5 to 3000 MHz	ZRB2	0373.9017.52
SWR Bridge, 40 kHz to 4 GHz	ZRC	1039.9492.52
High-power Attenuator, 100 W, 3/6/10/20/30 dB	RBU 100	1073.8820.XX (XX=03/06/10/20/30)
High-power Attenuator, 50 W 3/6/10/20/30 dB	RBU 50	1073.8895.XX (XX=03/06/10/20/30)
Preamplifier, 9 kHz to 30 MHz	ESH3-Z3	0827.8016.52
Preamplifier, 20 to 1000 MHz	ESV-Z3	0397.7014.52
For FSEM only: Adapter, N (male)	–	1021.0541.00
Adapter, 3.5 mm (male)	–	1021.0529.00

[1] Options FSE-B16 and FSE-B17 require option FSE-B15.





ROHDE & SCHWARZ
SPECTRUM ANALYZER

ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München
P.O.B. 801469 · D-81614 München · Telephone +4989 4129-0 · Fax +4989 4129-3567

ROHDE&SCHWARZ
EC Certificate of Conformity

CE

Certificate No.: 9502002

This is to certify that:

Equipment type	Order No.	Designation
FSEA20	1065.6000.20	Spectrum Analyzer
FSEA30	1065.6000.30	
FSEB20	1066.3010.20	
FSEB30	1066.3010.30	
FSEM20	1080.1505.20	
FSEM30	1079.8500.30	

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)

- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1991
EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 23.02.96

Central Quality Management FS-QZ / Becker

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 9502052

This is to certify that:

Equipment type	Order No.	Designation
FSE-B1	1073.4990.02	Color Display
FSE-B15	1073.5696.02 /.03	Computer Function
FSE-B16	1073.5973.02 /.03	Ethernet Interface
FSE-B17	1066.4017.02	2nd IEC BUS Interface
FSE-B2	1073.5044.02	7 GHz Frequency Extension
FSE-B4	1073.5396.02	OCXO 10 MHz and Low Phase Noise
FSE-B7	1066.4317.02	Signal-Vectoranalysis

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electromagnetic compatibility
  (89/336/EEC revised by 91/263/EEC, 92/31/EEC)

Conformity is proven by compliance with the following standards:

EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich,16.10.95

Central Quality Management FS-QZ / Becker

Supplement
to Operating Manual
Spectrum Analyzer FSEA20/30, FSEB20/30, FSEM20/30
(FirmwareVersion 1.30)

Modifications of firmware version 1.30 compared to previous versions:

PRESET settings:

For models FSEM20 and FSEM30 the preset setting of sweep time is 150 ms.

Channel-power measurement

The following soft keys have been added to the *MARKER-NORMAL-POWER MEAS SETTINGS* menu:

The *CH FILTER ON/OFF* soft key switches on or off a modulation filter for the channel power and adjacent-channel power measurements.

The filters of the digital mobile-radio standards NADC and TETRA are available. The selection of filters is made using the *STANDARD NADC/TETRA* soft key, which is automatically activated with *CH FILTER ON.*

CH FILTER ON — The channel bandwidth depends on the filter weighting. Therefore, the *CHANNEL BANDWIDTH* soft key is disabled.
The modulation filter switched on influences the subsequent measurements

- *CHANNEL POWER*
- *ADJ CHANNEL POWER*

In the filter definition range, the individual display points are weighted with the calculated filter attenuation according to their offset from the channel center. The weighted display points are subsequently summed up to the total power in the channel.

CH FILTER OFF — The *STANDARD NADC/TETRA* soft key is not active.

IEC bus command:

```
CALCulate<1|2>
 :MARKer<1 to 4>
   :FUNCtion
      :POWer
        :CFILTer <Boolean>
```

The *STANDARD NADC/TETRA* soft key selects the modulation filter for the channel power and adjacent-channel power measurements. The filters of the digital mobile-radio standards NADC and TETRA are offered for selection.

The soft key is only available, if the *CH FILTER* soft key is set to *ON.*

IEC bus command:

```
CALCulate<1|2>
 :MARKer<1 to 4>
   :FUNCtion
     :POWer
        :PRESet NADC|TETRA
```

Limit lines

The function of the limit lines has been modified. Replace the following section in the Operating Manual. For those soft keys, which have been added or modified, the IEC-bus command is indicated, in addition:

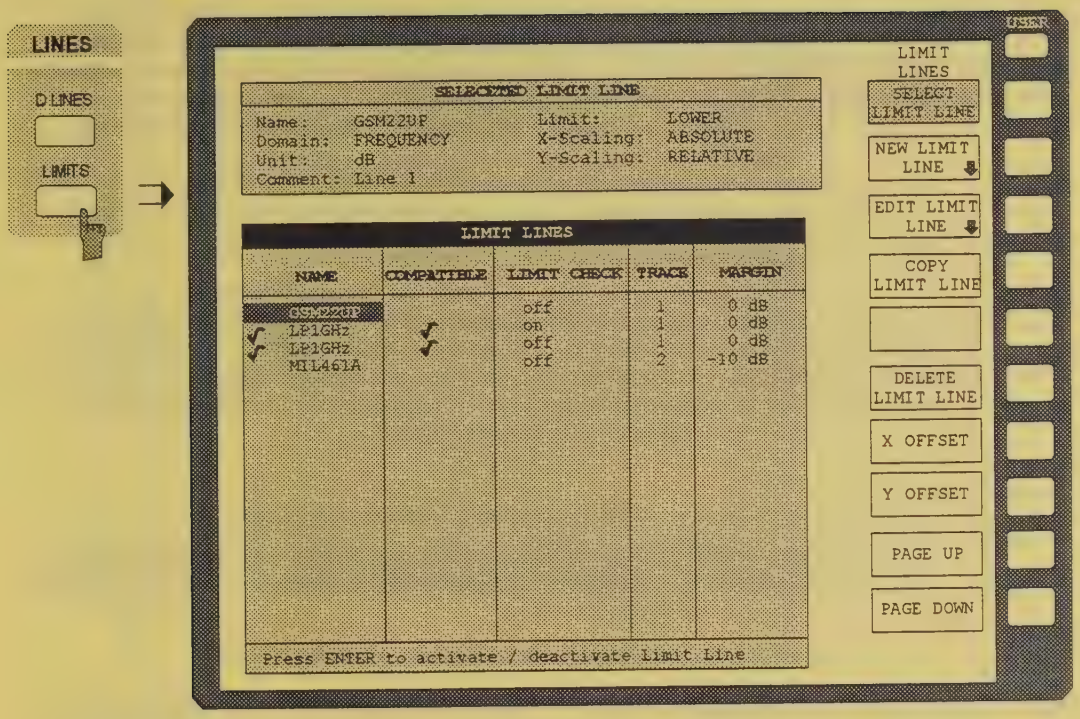
2.9.4.2 Limit Lines – *LIMITS Key*

Limit lines are used to define amplitude curves or spectral distribution boundaries on the display screen which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are permissible from a Unit Under Test (UUT). For transmission of information in TDMA (e.g., GSM), the amplitude of the bursts in a time slot must adhere to a curve which must fall within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The FSE instrument supports up to 300 limit lines, each of which may have a maximum of 50 data points. For each limit line, the following characteristics must be defined:

- The name of the limit line. The limit line data are stored under this name and can be examined in the table *LIMIT LINES.*
- The domain in which the limit line is to be used. Here, a distinction is made between the time domain (span = 0 Hz) and the frequency domain (span > 0 Hz).
- The reference of the interpolation points to the X-axis. The limit line may be specified either for absolute frequencies or times or for frequencies which are related to the set center frequency and times related to the time on the left edge of the diagram.
- The reference of the interpolation points to the Y-axis. The limit line can be selected either for absolute levels or voltages or referred to the set maximum level (Ref Lvl or Max Lvl). If the reference line is switched on, it is used as reference when relative setting has been selected.
- The type of limit line (upper or lower limit). With this information and the active limit checking function (*LIMIT CHECK soft key*), the FSE checks for compliance with each limit.
- The limit line units to be used. The units of the limit line must be compatible with the level axis in the active measurement window.
- The measurement curve (trace) to which the limit line is assigned. For the FSE, this defines the curve to which the limit is to be applied when several traces are simultaneously displayed.
- For each limit line, a margin can be defined which serves as a threshold for automatic evaluation.
- In addition, commentary can be written for each limit line, e.g., a description of the application.

In the *LINES LIMIT* menu, the compatible limit lines can be enabled in the *LIMIT LINES* table. The *SELECTED LIMIT LINE* display field provides information concerning the characteristics of the marked limit lines. New limit lines can be specified and edited in the *NEW LIMIT LINE and EDIT LIMIT LINE* sub-menus, respectively.



2.9.4.2.1 Limit Line Selection

The *SELECTED LIMIT LINES* table provides information about the characteristics of the marked limit line :

Name	name
Domain	frequency or time
Limit	upper/lower limit
X-Scaling	absolute or relative frequencies/times
Y-Scaling	absolute or relative Y-units
Unit	vertical scale
Comment	commentary

The characteristics of the limit line are set in the *EDIT LIMIT LINE (=NEW LIMIT LINE)* sub-menu.

The *SELECT LIMIT LINE* soft key activates the *LIMIT LINES* table and the selection bar jumps to the uppermost name in the table.

The columns contain the following information:

Name	enable the limit line.
Compatible	indicate whether the limit line is compatible with the measurement window of the given trace.
Limit Check	activate automatic violation check for upper/lower limits.
Trace	select the measurement curve to which the limit is assigned.
Margin	define margin.

Name and Compatible **- Enabling limit lines**

A maximum of 8 limit lines can be enabled at any one time. A check mark at the left edge of a cell indicates that this limit line is enabled. A limit line can only be enabled when it has a check mark in the *Compatible* column, i.e., only when the horizontal display (time or frequency) and vertical scales are ***identical*** to those of the display in the measurement window.
Lines with the unit dB are compatible to all dB(..) settings of the Y-axis.
If the trace assigned to a line is not switched on, the line is displayed in the window the trace would be displayed in.
Example:
In split screen mode, trace 2 is assigned measuring window B. A line assigned to trace 2 is always displayed in measurement window B.
If the scale of the Y-axis or the domain (frequency or time axis) are changed, all non-compatible limit lines are automatically switched off in order to avoid misinterpretation. The limit lines must be enabled anew when the original display is re-displayed.

Limit Check **- Activate automatic limit violation check**

When *LIMIT CHECK ON* is activated, a GO/NOGO test is performed. In the center of the diagram, a display window appears which indicates the results of the limit check test:

LIMIT CHECK: PASSED	No violations of active limits.
LIMIT CHECK: FAILED	One or more active limit lines were violated. The message contains the names of the limit lines which were violated or whose margins were not complied with.
LIMIT CHECK: MARGIN	The margin of at least one active limit lines was not complied with, however, no limit line was violated. The message contains the names of the limit lines whose margins were not complied with.

The following example shows three active limit lines:

A check for violations of limit lines takes place only if the limit line of the assigned measurement curve (trace) is enabled.
If *LIM CHECK* is set to *OFF* for all active limit lines, then the limit line check is not executed and the display window is activated.

Trace **- Select the measurement curve to which the limit line is assigned.**

The selection of the measurement curve (trace) takes place in an entry window. Allowed are the integer entries 1, 2, 3 or 4. The default setting is trace 1. If the selected limit line is not compatible with the assigned measurement curve, then the limit line is disabled. (display and limit check).

Margin **- Setting a margin.**

The margin is defined as the signal-level distance to the limit line. When the limit line is defined as an upper limit, the margin means that the level is below the limit line. When the limit line is defined as a lower limit, the margin means that the level is above the limit line. The default setting is 0 dB (i.e., no margin).

IEC bus command
```
CALCulate<1|2>
    :LIMit<1 to 8>
        :UPPer|:LOWer
            :MARGin <numeric_value> dB
```

The *COPY LIMIT LINE* soft key copies the data file describing the marked limit line and saves it under a new name. In this way, a new limit line can be easily generated by parallel translation or editing of an existing limit line. The name can be arbitrarily chosen and input via an entry window (max. of 8 characters).

Pressing the *DELETE LIMIT LINE* soft key erases the selected limit line. Before deletion, a message appears requesting confirmation.

The *X OFFSET* soft key is used to horizontally shift a limit line which has been specified for relative frequencies or times (X-axis). The soft key opens an entry window, where the value for shifting may be entered numerically or via the roll-key.

Note: *When changing the start or stop frequencies, the line on the display is only retained, if SPAN FIXED is set.*

IEC bus command
```
CALCulate<1|2>
    :LIMit<1 to 8>
        :CONTrol
            :OFFSet <numeric_value> dB
```

The *Y OFFSET* soft key is used to vertically shift a limit line, which has relative values for the Y-axis (levels or linear units such as volt). The soft key opens an entry window where the value for shifting may be entered numerically or via the roll-key.

IEC bus command
```
CALCulate<1|2>
    :LIMit<1 to 8>
    :UPPer|:LOWer
        :OFFSet <numeric_value> dB
```

Pressing the *PAGE UP/DOWN* soft key sets the limit line table to the next/previous page.

2.9.4.2.2 Entry and Editing of Limit Lines

A limit line is characterized by

- its name
- the assignment of domain (frequency or time)
- the scaling in absolute or relative times or frequencies
- the vertical unit
- the vertical scaling
- the definition of the limit line as either upper or lower limit.
- the data points for frequency/time and level

At the time of entry, the FSE immediately checks that all limit lines are in accordance with certain guidelines. These guidelines must be observed if specified operation is to be guaranteed.

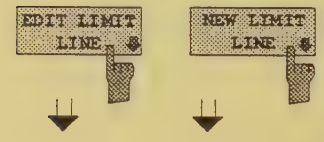
- The frequencies/times for each data point must be entered in ascending order, however, for any single frequency/time, two data points may be input (vertical segment of a limit line).

  The data points are allocated in order of ascending frequency/time. Gaps are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.

- The entered frequencies/times must not necessarily be selectable in FSE. A limit line may also exceed the specified frequency or time domains. The minimum frequency for a data point is 0 Hz, the maximum frequency is 200 GHz. For the time domain representation, negative times may also be entered. The allowable range is -1000 s to +1000 s.

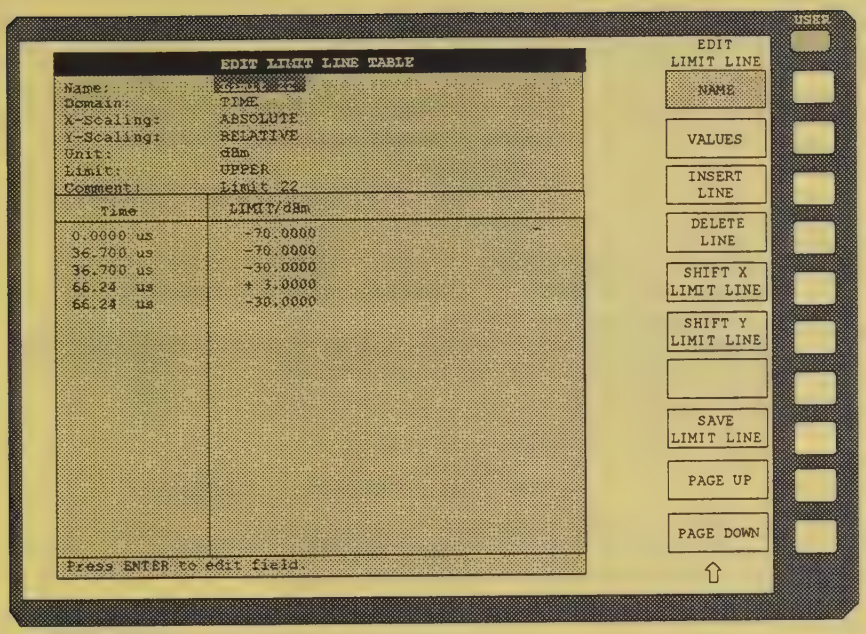
- The minimum/maximum value for a limit line is -200 dB to +200 dB for the logarithmic or 10^{-20} to 10^{+20} or-99.9% to + 999.9% for the linear amplitude scales.

LINES LIMIT-EDIT LIMIT LINE menu



The *EDIT LIMIT LINE* and *NEW LIMIT LINE* soft keys both call the *EDIT LIMIT LINE* sub-menu used for editing limit lines. In the table heading, the characteristics of the limit line can be entered. The data points for frequency/time and level values are entered in the columns.

Name	Enter name.
Domain	Select domain.
X-Scaling	Entry of absolute or relative values for the X-axis
Y-Scaling	Entry of absolute or relative values for the Y-axis
Unit	Select units.
Limit	Select upper/lower limit.
Comment	Enter comments.
Time/Frequency	Enter time/frequency for the data points.
Limit/dBm	Enter magnitudes for the data points.



The *NAME* soft key enables the entry of characteristics in the table heading.

Name **- Enter name**

A maximum of 8 characters are permitted for each name. All names must be compatible with the MS DOS conventions for file names. The instrument stores all limit lines with the .LIM extension.

Domain **- Select time or frequency domain**

A change in domain (frequency/time) is only permitted when the data point table is empty. The default setting is frequency.

Scaling **- selection of absolute or relative scaling**

The limit line can either be scaled in absolute (frequency or time) or relative units. Any of the unit keys may be used to toggle between *ABSOLUTE* and *RELATIVE*, the cursor must be positioned in the *X-Scaling* or the *Y-Scaling* line

X-Scaling ABSOLUTE The frequencies or times are interpreted as absolute physical units.

X-Scaling RELATIVE In the data point table, the frequencies are referred to the currently set center frequency. In time domain mode, the left boundary of the diagram constitutes the reference.

Y-Scaling ABSOLUTE The limit values refer to absolute levels or voltages.

Y-Scaling RELATIVE The limit values refer to the reference level (Ref Level) or, in case a reference line is set, to the reference line.
Limit values with the units dB or % are always relative values.

The *RELATIVE* scaling is always suitable, if masks for bursts are to be defined in the time domain, or if masks for modulated signals are required in the frequency domain.
An X-offset with half the sweep time may be entered in order to shift the mask in the time domain into the center of screen.

IEC bus command
```
CALCulate<1|2>
    :LIMit<1 to 8>
        :CONTrol
            :MODE RELative | ABSolute
        :UPPer | :LOWer
            :MODE RELative | ABSolute
```

***Unit* - selection of the vertical unit for the limit line**

The selection of the unit is made in the selection box. The default setting is dBm.

***Limit* - Select upper/lower limit**

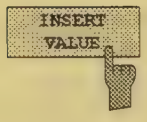
A limit line can be defined as either an upper or lower limit.

***Comment* - Enter comments**

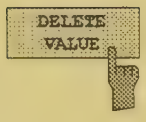
Comments are arbitrary, however, they must be less than 40 characters long.

The *VALUES* soft key activates the entry of the data points in the table columns *Time/Frequency* and *Limit/dB*. Which table columns appear depends upon the *Domain* selection in the table heading.

The desired frequency/time data points are entered in ascending order (two repeated frequencies/time values are permitted).



The *INSERT VALUE* soft key creates an empty line above the current cursor position where a new data point may be entered. However, during the entry of new values, it is necessary to observe an ascending order for frequency/time.



The *DELETE VALUE* soft key erases the data point (complete line) at the cursor position. All succeeding data points are shifted down accordingly.

The *SHIFT X LIMIT LINE* soft key calls an entry window where the complete limit line may be shifted parallel in the horizontal direction.

The shift takes place according to the horizontal scale:

- in the frequency domain in Hz, kHz, MHz or GHz
- in the time domain in ns, µs, ms or s

In this manner, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally and stored (*SAVE LIMIT LINE* soft key) under a new name (*NAME* soft key).

The *SHIFT Y LIMIT LINE* soft key calls an entry window where the complete limit line may be shifted parallel in the vertical direction.

The shift takes place according to the vertical scale:

- for logarithmic units, relative, in dB
- for linear units, as a factor

In this manner, a new limit line can be easily generated based upon an existing limit line which has been shifted vertically and stored (*SAVE LIMIT LINE* soft key) under a new name (*NAME* soft key).

The *SAVE LIMIT LINE* soft key stores the currently edited limit line . The name can be entered in an input window (max. 8 characters)

Pressing the *PAGE UP* soft key displays the next page of data points.

Pressing the *PAGE DOWN* soft key displays the previous page of data points.

1 Preparing for Operation

1.1 Introduction

1.2 Description of Front and Rear Panel Views

1.2.1 Front View

1

Display Screen

see Chap.2, Section 2.3.1

2

Soft Keys

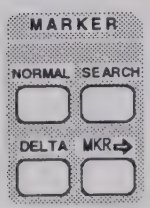
see Chap.2, Section 2.3

3 USER

Writing Macros

see Chap. 2, Section 2.8

4 MARKER

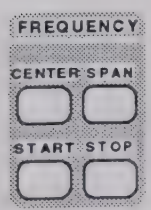


Select and set marker

NORMAL	Select and set the marker
SEARCH	Set and start the peak/min search
DELTA	Select and set the delta marker
MKR ⇒	Set the active marker

see Chap. 2, Section 2.2 and Section 2.9.3

5 FREQUENCY



Define frequency axis in the active window

CENTER	Set center frequency
SPAN	Set sweep width
START	Set start frequency
STOP	Set stop frequency

see Chap. 2, Section 2.2 and Section 2.9.1

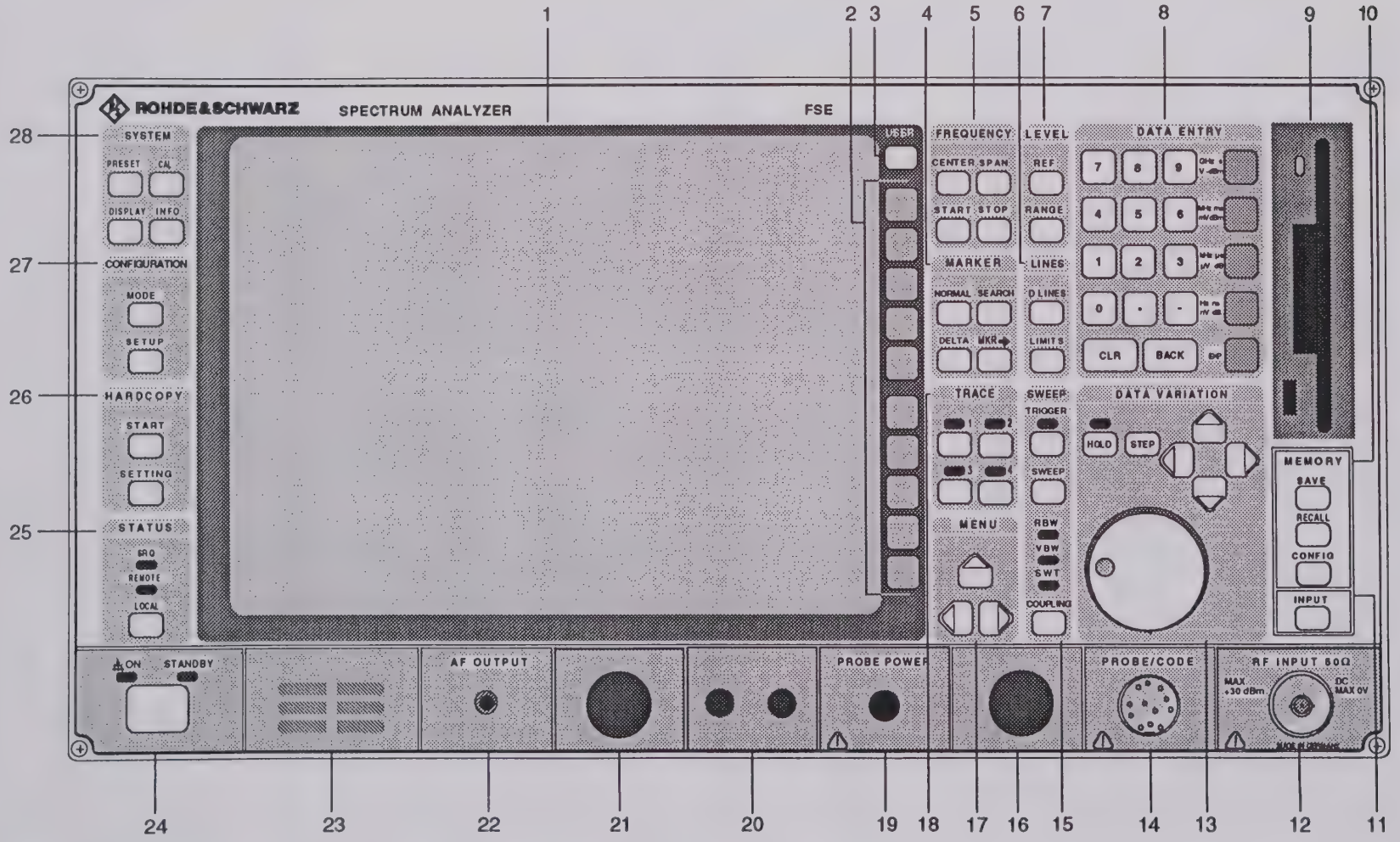


Figure 1.2-1 Front View

6 LINES

Setup evaluation lines and tolerance limits

D LINES — Setup evaluation lines (display lines)

LIMITS — Definition and recall of tolerance limits

see Chap. 2, Section 2.2 and Section 2.9.4

7 LEVEL

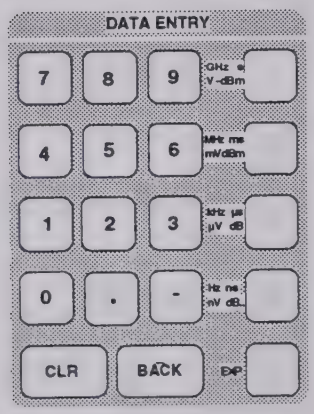
Define reference levels and display range in the active measurement window.

REF — Set reference level (= max. display level)

RANGE — Set range

see Chap.2, Section 2.2 and Section 2.9.2

8 DATA ENTRY



Keypad for data input

0...9 — input numbers

. — input decimal point

– — change sign

CLR
- close input field (for uncompleted or already closed inputs, the original entry is kept)
- erase the current entry in input field (beginning of an input)
- close message window (status, error and warning messages)

BACK — erase last character input

GHz s
V -dBm
MHz ms
mV dBm
kHz µs
µV dB..
Hz ns
nV dB

The units keys close the data input and define the multiplication factor for each basic unit. For dimension-less or alphanumeric inputs, the units keys have weight 1. They behave, in this case, like the ENTER key.

EXP — Append an exponent

see Chap.2, Section 2.3

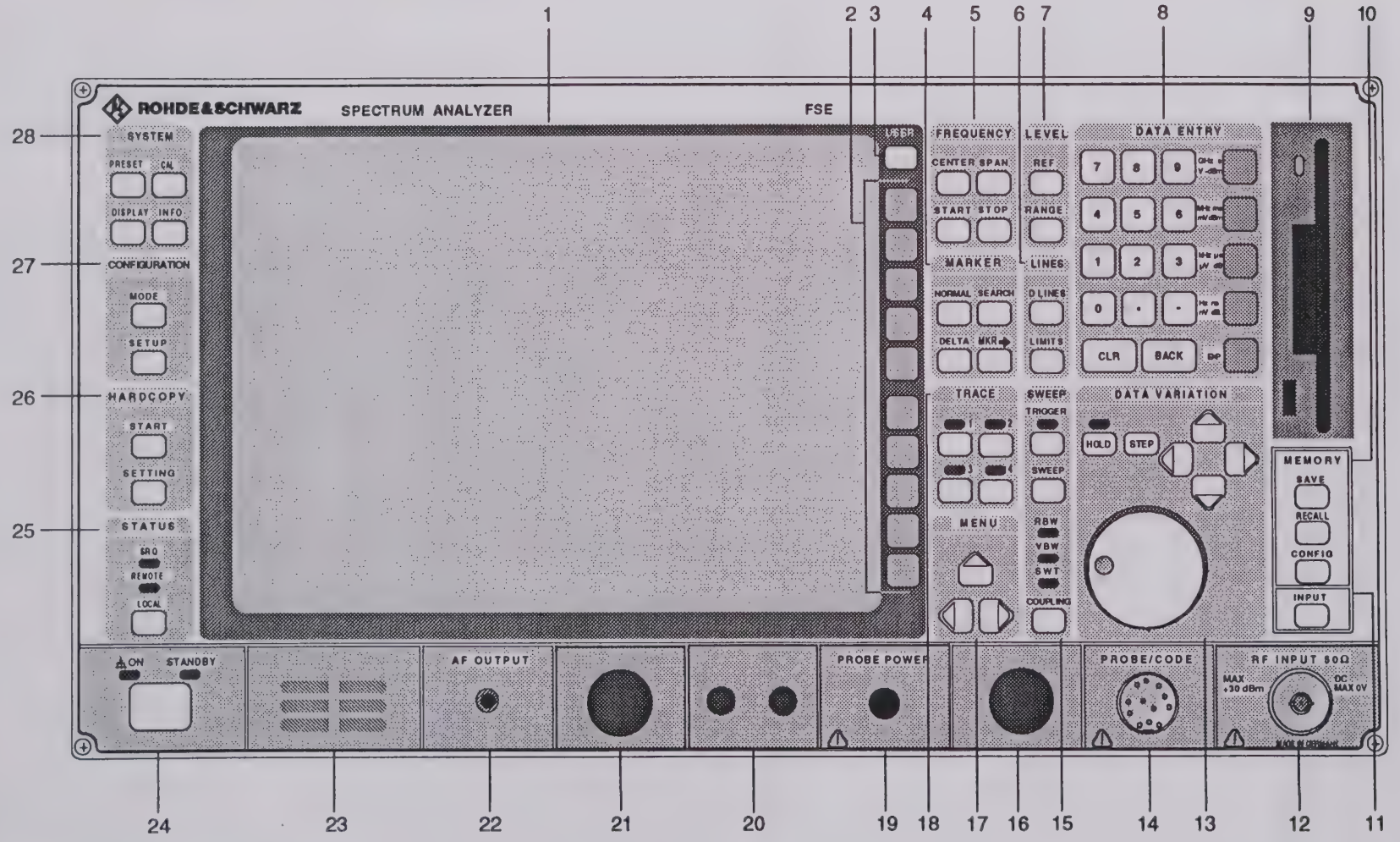
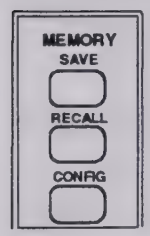


Figure 1.2-1 Front View

9

3 1/2" diskette drive; 1.44 MByte

10 MEMORY



Memory media and file management

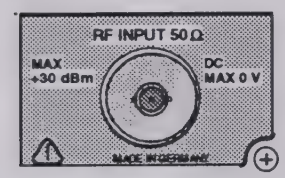
SAVE	Save instrument data
RECALL	Recall instrument data
CONFIG	Configuration of memory media and data

see Chap. 2, Section 2.2 and Section 2.7

11 INPUT

Set impedance and attenuation at the RF input.

12 RF INPUT

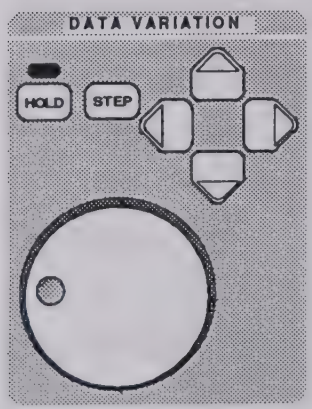


RF-Input

Caution:
The maximum DC voltage is 0 V, the maximum power is 1 W (≙ 30 dBm at ≥ 10 dB attenuation)

see Chap. 2 Section 2.9.2.4

13 DATA VARIATION



Key group for entering data and for cursor movement

HOLD	Disable control elements / overall control. The LED indicates the hold condition.
STEP	Set step size for cursor keys and roll-key.
Cursor keys	– Move the cursor within the input fields and tables. – Vary the input value. – Define the direction of movement for the roll-key.
Roll-key	– Vary input values. – Move markers and limits. – Select letters in the help line editor. – Move cursor in the tables

see Chap. 2, Section 2.3

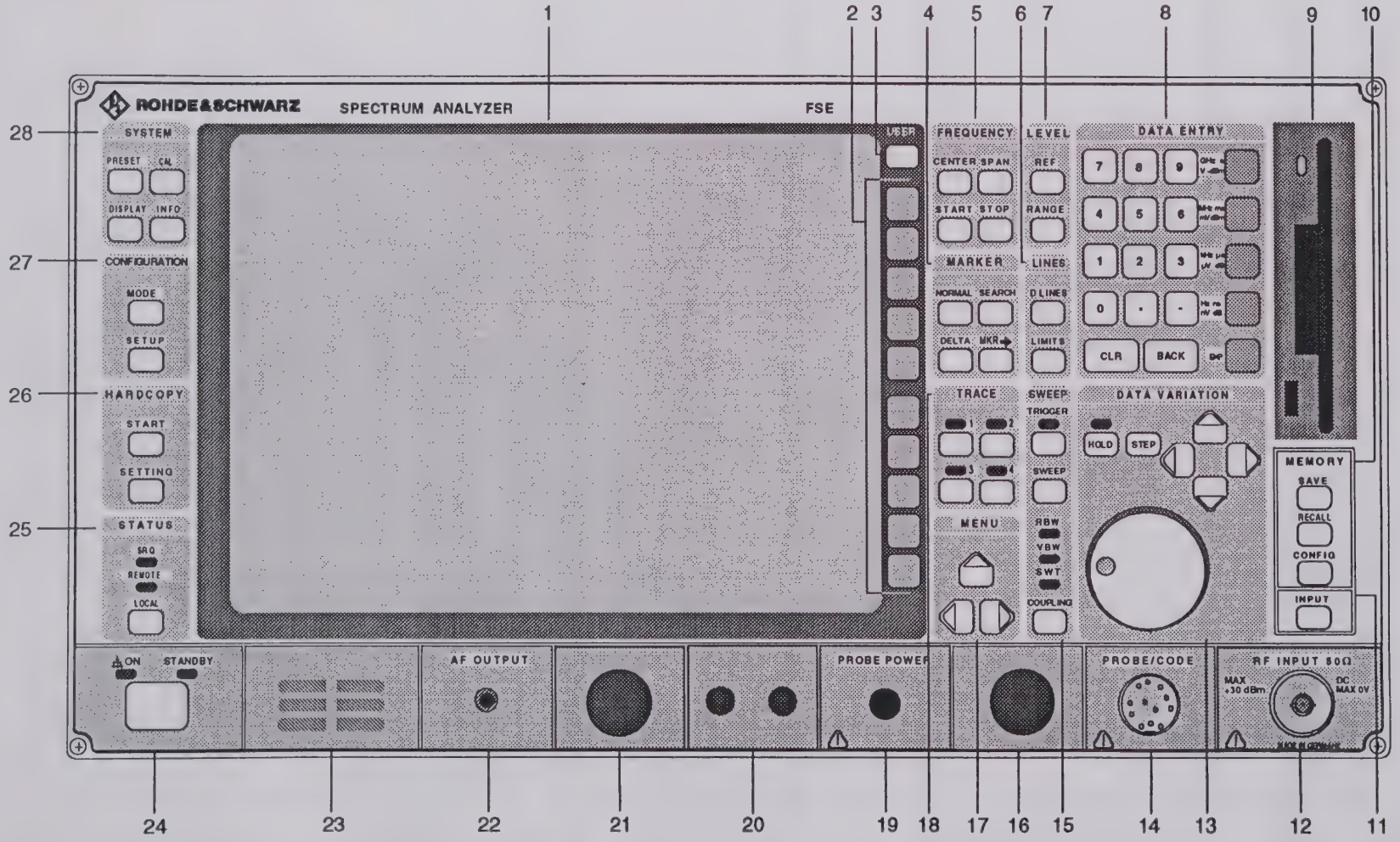
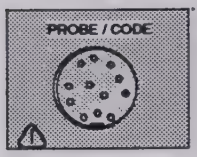


Figure 1.2-1 Front View

14 PROBE/CODE



Power supply and coded socket for R&S accessories.(12-pin Tuchel)

15 SWEEP

Input sweep parameters

TRIGGER Set trigger source. The LED illuminates on valid trigger.

SWEEP Set type of sweep.

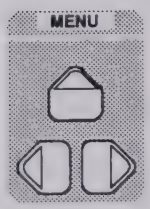
COUPLING Set coupled parameters. Resolution BandWidth (RBW), Video BandWidth (VBW) and SWeep Time (SWT). The LEDs light indicating coupled parameters which are manually cancelled.

see Chap. 2, Section 2.2 and Section 2.9.6

16

Reserved for options

17 MENU



Menu-change keys

Call main menu

Change to left menu

Change to right menu

see Chap. 2, Section 2.3.2

18 TRACES

Select and activate measurement traces (Trace 1...4).

The LEDs indicate traces turned on.

see Chap. 2, Section 2.2 and Section 2.9.5

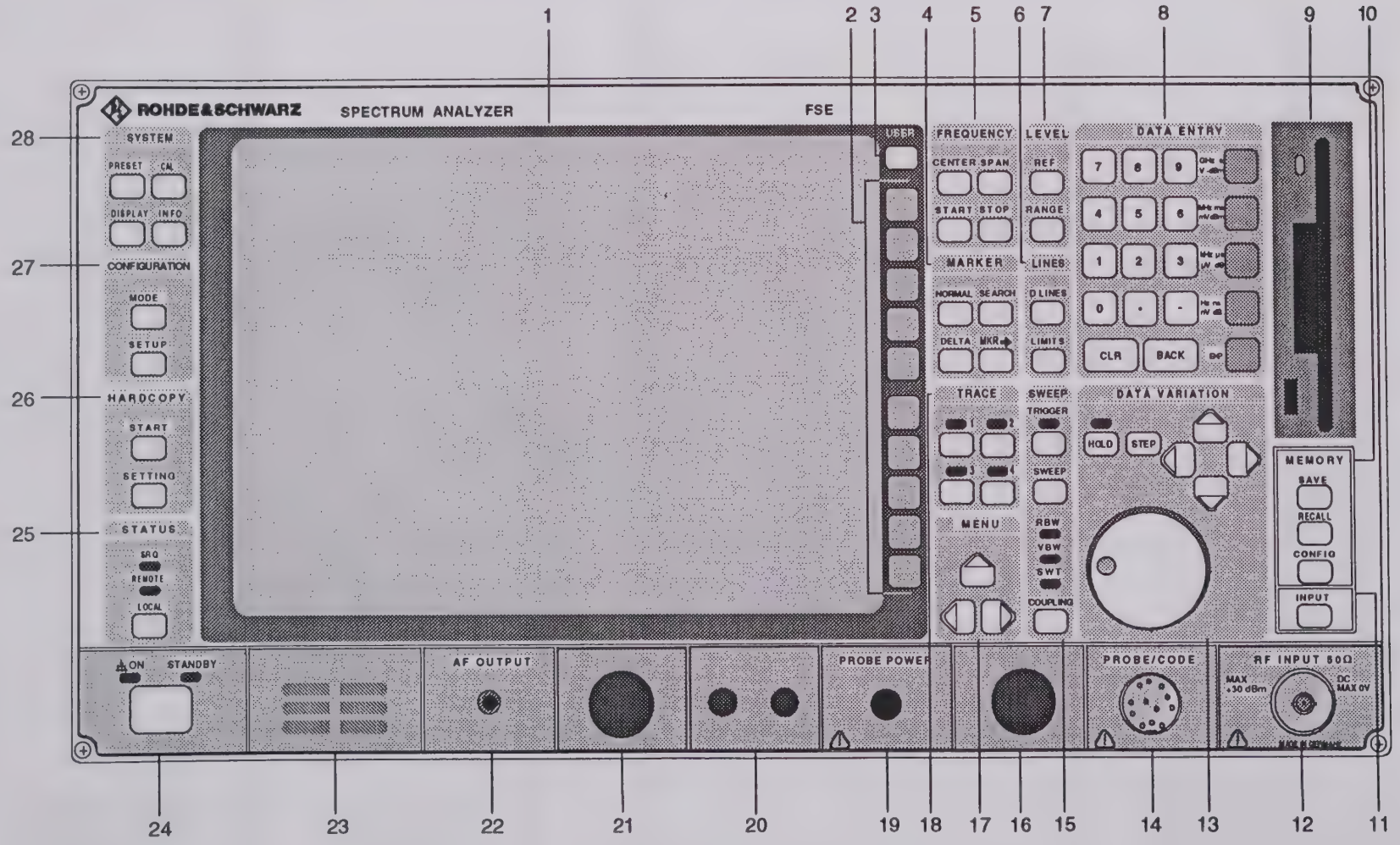


Figure 1.2-1 Front View

19 PROBE POWER

Power supply connector (+15V / - 12.6V) for measurement accessories (probes)

see Annex A

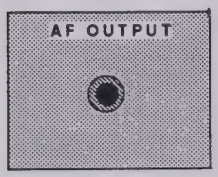
20

Reserved for options

21

Reserved for options

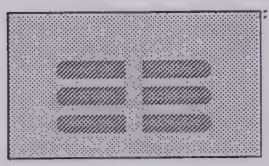
22 AF OUTPUT



AF output connector (head phones) (miniature phone jack)

see Annex A

23

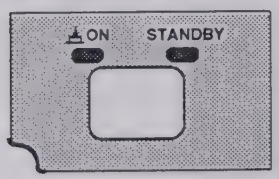


Internal loudspeaker

The loudspeaker is disabled when the phone jack is inserted in the AF output.

see Annex A

24



ON/STANDBY

Caution:
In standby mode, the AC line voltage is still present within the instrument.

see Chap. 1, Section 1.3.6

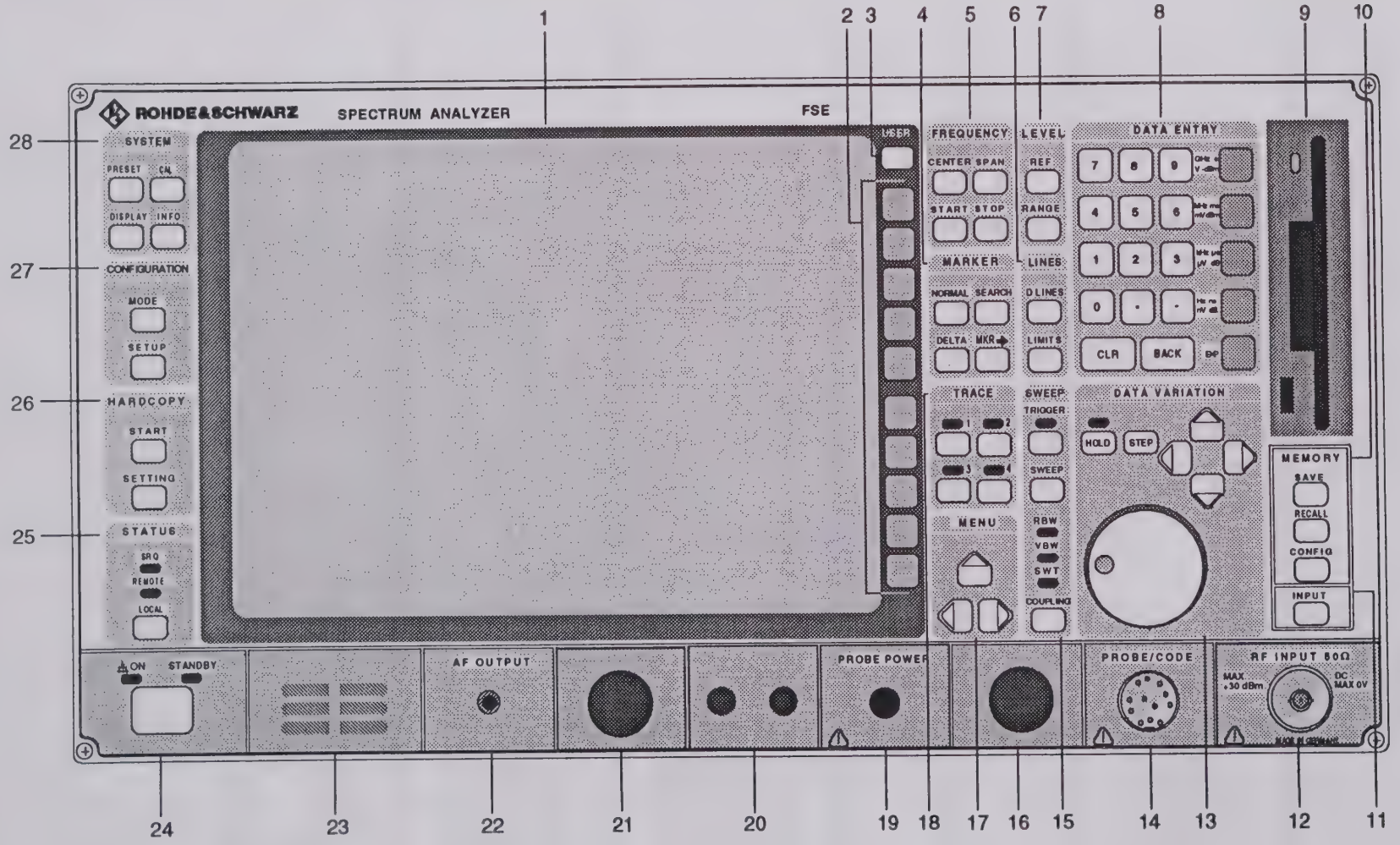


Figure 1.2-1 Front View

25 STATUS

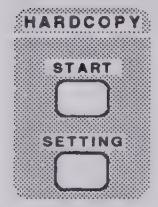
Indicators for remote control and switch for manual control.

LOCAL — Switch from remote to manual control.

The LED SRQ indicates that a service request from the instrument is active on the IEC Bus.
The LED REMOTE indicates that the instrument is under remote control.

see Chap. 2, Section 2.5 and Chap. 3, Section 3.3

26 HARDCOPY



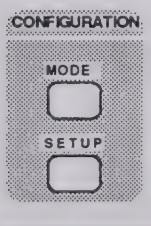
Printer control

START — Start a print job with the setup defined in the SETTING menu.

SETTING — Configure the diagram, parameter list and measurement protocol outputs on the various output media.

see Chap. 2 Sections 2.2 and 2.6

27 CONFIGURATION



Select operational modes and define default settings

MODE — Select mode

SETUP — Define default settings

see Chap. 1, Sections 1.4 to 1.7 and Chapter 2, Section 2.2 and Sections 2.4.5 to 2.4.6

28 SYSTEM

General instrument default settings

PRESET — Recall instrument default settings

DISPLAY — Configure the display screen format

CAL — Calibrate the analyzer

INFO
- Information concerning instrument state and measurement parameters
- Call help functions

see Chap. 2 Section 2.2 and Sections 2.4.1 to 2.4.4

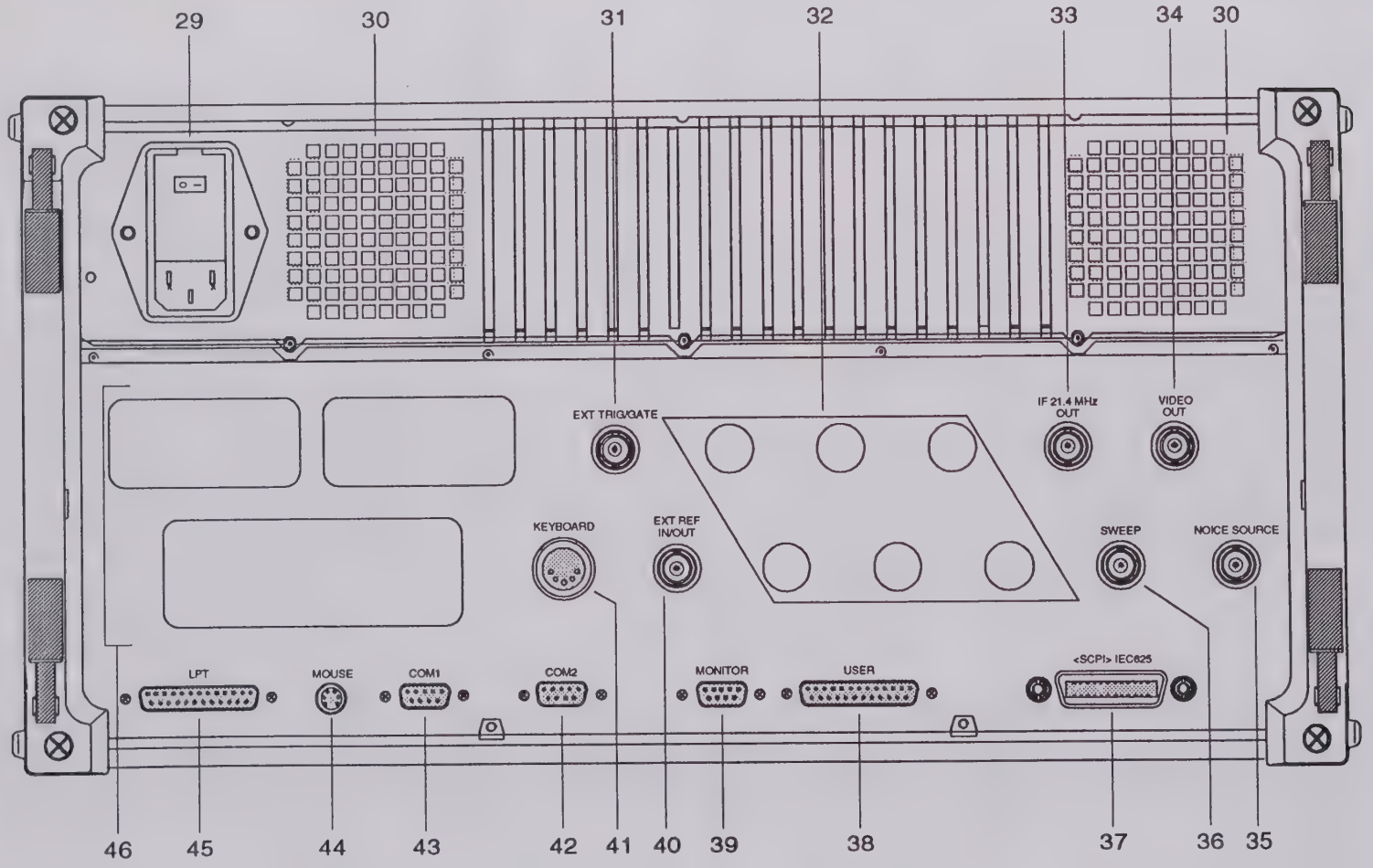
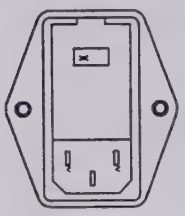


Figure 1.2-2 Rear View

1.2.2 Rear View

29



Power switch

Fuse holder

AC power connector

see Chap. 1, Section 1.3.4

30

Power supply fans

31 EXT TRIG/GATE

EXT TRIG/GATE

Input connector for an external trigger or an external gate signal

see Chap. 2, Section 2.9.6 and Annex A

32

Reserved for options

33 IF 21.4 MHZ OUT

IF 21.4 MHz OUT

Output connector for 21.4 MHz IF

see Annex A

34 VIDEO OUT

VIDEO OUT

Output connector for video signal

see Annex A

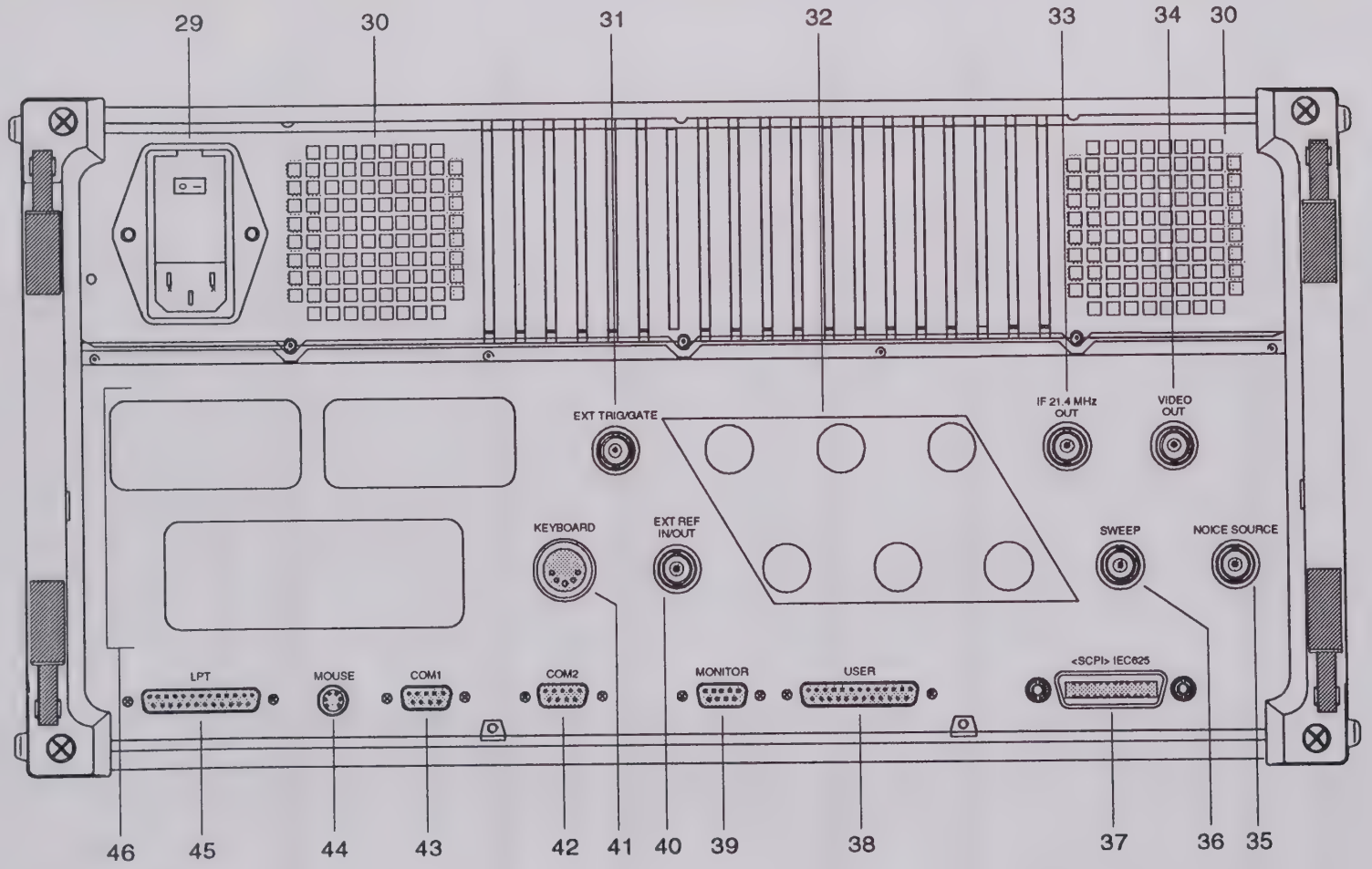


Figure 1.2-2 Rear View

35 NOISE SOURCE

NOICE SOURCE

Output connector for a switchable noise source

see Annex A

36 SWEEP

SWEEP

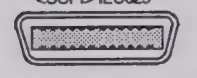
Output connector

During a sweep, a sawtooth voltage is output which is proportional to frequency.

see Annex A

37 <SCPI> IEC625

<SCPI> IEC625



IEC Bus-connector

see Annex A

38 USER

USER

User interface connector with configurable inputs and outputs (USER-PORT A and USER-PORT B)

see Annex A

39 MONITOR

MONITOR

Connector for an external VGA monitor

see Annex A

40 EXT REF IN/OUT

EXT REF IN/OUT

Input connector for an external reference (1 to 16 MHz), switchable to 10 MHz output

see Chap. 2, Section 2.4.6.1 and Annex A

41 KEYBOARD

KEYBOARD

Connector for an external keyboard (5-pin DIN socket)

see Chap. 1 Section 1.6 and Annex A

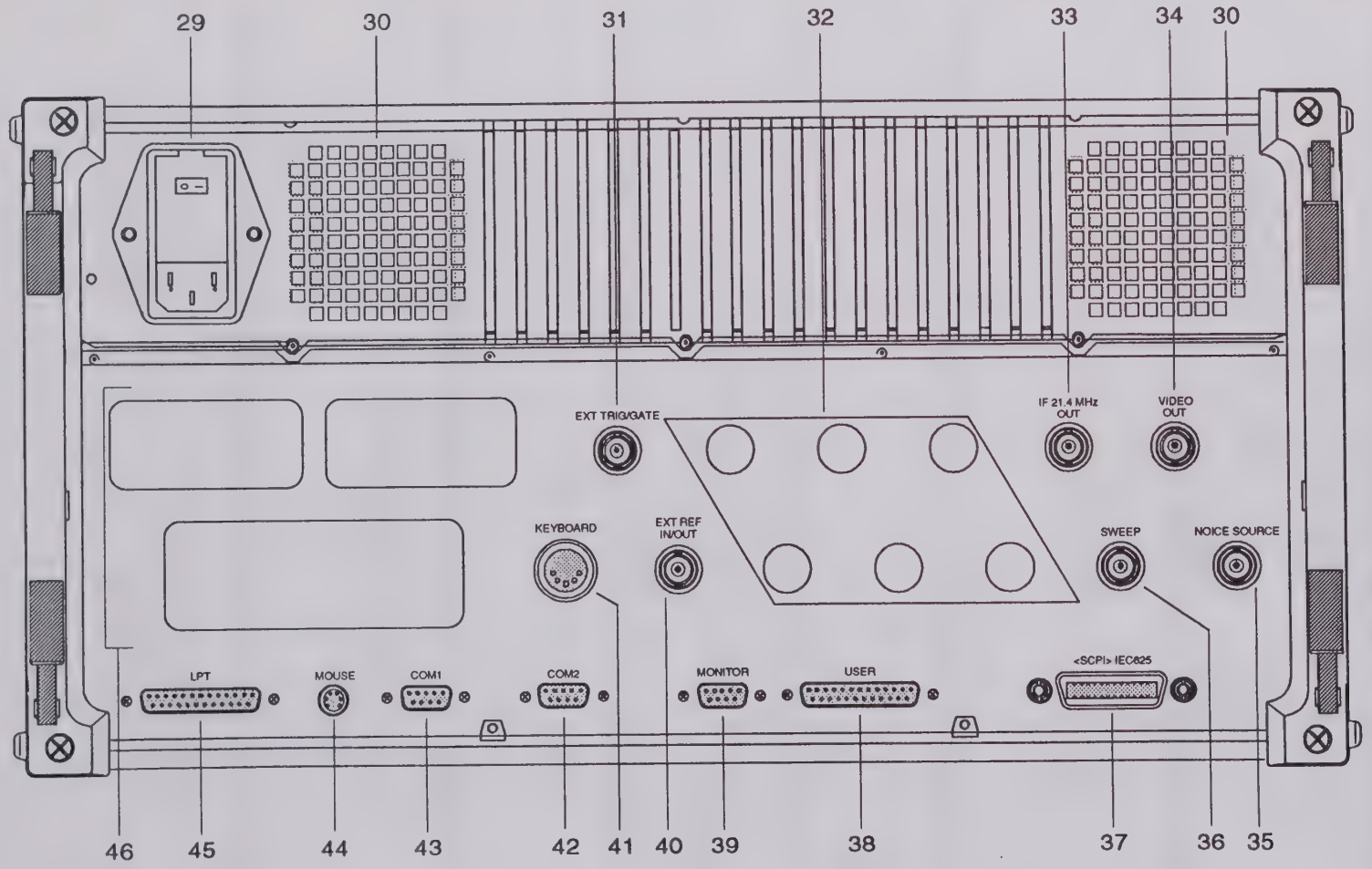


Figure 1.2-2 Rear View

42 COM2

Connector for serial interface 2
(9-pin socket; COM2)

see Chap. 1
Section 1.7
and
Annex A

43 COM1

Connector for serial interface 1
(9-pin socket; COM1)

see Chap. 1
Section 1.7
and
Annex A

44 MOUSE

Connector for a PS/2 mouse

see Chap.1
Section 1.5
and
Annex A

45 LPT

Parallel interface connector
(printer connector, Centronics compatible)

see Chap. 1
Section 1.7
and
Annex A

46

Inputs / Outputs for options
(cover plates for digital interface expansion)

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1.3 Start-Up

Important Note:

Before turning the instrument on, it must be observed that the following conditions are fulfilled:

- *instrument covers are in place and all fasteners are tightened,*
- *fan openings are free from obstructions,*
- *signal levels at the input connectors are all within specified maximums,*
- *signal outputs are correctly connected.and not overloaded.*

Non-observance may cause damage to the instrument .

1.3.1 Unpacking the Instrument

After the instrument has been removed from its packaging, insure that all deliverable items are present as follows:

- spectrum analyzer
- AC power cable
- operating manual

Now check the instrument for visible mechanical damage. If damage is present, promptly inform the delivery firm that delivered the instrument. In case damage is found, retain the carton and the packing materials.

1.3.2 Instrument Setup

1.3.2.1 Stand-alone Operation

The spectrum analyzer is designed for use under general laboratory conditions. The ambient conditions required at the operational site are as follows:

- The ambient temperature must be in the range of + 5 ... + 45 °C.
- All fan openings must be unobstructed and the air exhaust at the rear panel and at the side-panel perforations must not be covered. The distance to the wall should be at least 10 cm.
- The mounting surface should be flat.

For applications in the laboratory or on a work bench, it is recommended that the support feet on the bottom of the instrument be extended. For the LCD display, this provides the optimum viewing angle which typically ranges from perpendicular to the display front to approximately 30° below.

1.3.2.2 19" Rack Installation

Important Note:

For rack installation, insure that the air flow at the side-panel perforations and the air exhaust at the rear panel are not obstructed.

The instrument may be mounted in a 19" rack by using the rack adapter kit ZZA-95 (order number: 396.4911.00). The installation instructions are included in the adapter kit.

1.3.3 EMI Protection Measures

In order to prevent electromagnetic interference (EMI), the instrument may be operated only when all covers are correctly in place. Only adequately shielded signal and control cables may be used (see recommended accessories).

1.3.4 Connecting to AC Power

The spectrum analyzer is equipped with an AC voltage selection feature and will automatically set itself according to the applied AC voltage (range: 90 ... 132 VAC and 180 ... 265 VAC, 47 ... 440 Hz). The AC power connector is located on the rear panel (see below).

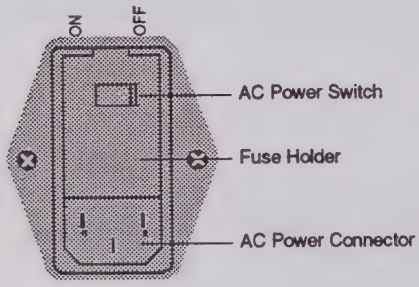
➢ Connect the spectrum analyzer to the AC power source using the AC power cable delivered with the instrument.

1.3.5 AC Power Line Fuses

The spectrum analyzer is protected by two fuses as specified on the power supply name-plate. The fuses are located in a removable fuse holder which is located between the AC power switch and the AC power connector (see below).

1.3.6 Instrument On/Off

AC power switch on the rear panel



Power On/Off

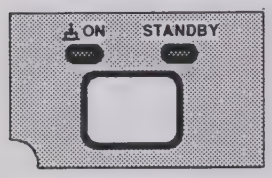
➢ Depress the AC Power Switch to the desired position ON/OFF.

After turn-on (position ON), the instrument is in the ready state (STANDBY) or in operation dependent upon the position of the ON/STANDBY switch located on the instrument front panel (see below).

Note: *The AC power switch may remain ON continuously. Switching to OFF is only required when the instrument must be completely removed from the AC power source.*

Switching to OFF (position OFF) removes all instrument circuitry from the AC power source.

ON/STANDBY switch on the front panel



Standby

➢ ON/STANDBY switch is not depressed.

The yellow LED (STANDBY) is illuminated. The DC power supply is supplied with power and the quartz oven is maintained at normal operating temperature.

Operation

➢ ON/STANDBY is depressed.

The green LED (ON) is illuminated. The instrument is ready for operation. All modules within the instrument are supplied with power.

Caution:

In standby mode, the AC power voltage is present within the instrument.

1.3.7 Battery-Powered Memory

The spectrum analyzer is equipped with a battery-powered read/write memory (CMOS-RAM) where instrument settings are saved at power-off. After each power-on, the spectrum analyzer is reloaded with the operational parameters which were active just prior to the last power-off (STANDBY or AC power OFF).

A lithium battery is used to supply power to the CMOS-RAM. When the battery is depleted (expected life is approx. 5 years), any data stored in CMOS-RAM will be lost. In this case, the factory standard setup is loaded at turn-on. Changing batteries is described in Chapter 4, Section "Changing Batteries" .

1.4 Functional Test

After turning on the AC power, the spectrum analyzer returns the following message to the display screen:

Analyzer BIOS
Rev. x.y

Copyright
Rohde & Schwarz
Munich

Booting

After appearance of the above message, a self-test of the digital hardware is performed. Any errors which occur in self-test are transferred as ASCII text to the printer interface (LPT). Thus, an error diagnosis can be carried out, even for serious failures. A check of the data contents of the spectrum analyzer is performed in self calibration (CAL, *CAL TOTAL* key) The individual results of the calibration (PASSED / FAILED) can be displayed in the calibration menu.
With the aid of the built-in self-test functions (*INFO* key, *SELFTEST* soft key), the functional integrity of the analyzer can be verified and/or defective modules can be localized.

1.5 Connecting a Mouse

Caution:
The mouse may only be connected when the instrument is switched off (STANDBY). Otherwise, correct operation of the mouse and instrument cannot be guaranteed.

In order to ease manual operations, the spectrum analyzer provides an option for connecting a mouse to a PS/2 mouse (MOUSE) or a serial interface (COM1 or COM2) connector.

During measurement operation, soft keys, tables and data input fields may also be controlled via the mouse. With the installed option FSE-B15, the mouse can be selectively assigned to measurement instrument operation, DOS operation or both modes of operation. If the option FSE-B15 is not installed, then the mouse can only be assigned to measurement instrument operation.

The control functions for the mouse are described in Chapter 2 in the section "Mouse Operations". Appendix E contains a list in which the screen display elements for mouse control of the corresponding soft keys and push buttons of the instrument are described. Appendix A contains the interface description.

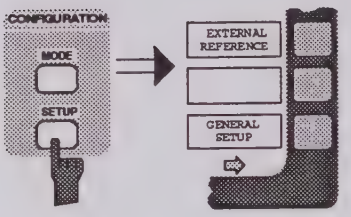
The Microsoft mouse is the supported mouse type and is available under option PS-B1 (order number 1006.6359.02). The mouse connectors are located on the rear panel.

After connection of the mouse, the selected interface must be configured and the mouse assigned to either single or dual mode of operation.

The configuration is performed according to menu *SETUP-GENERAL SETUP* (key group: *CONFIGURATION*, see in Chapter 2, the section "Preliminary Setup and Interface Configuration").

- The parameter *MOUSE INTERFACE* configures the selected interface.
- The parameter *MOUSE OWNER* assigns the mouse to either single or dual mode of operation.

In the following illustrative example, the mouse is connected to the PS/2 interface and is assigned to the dual mode of operation.



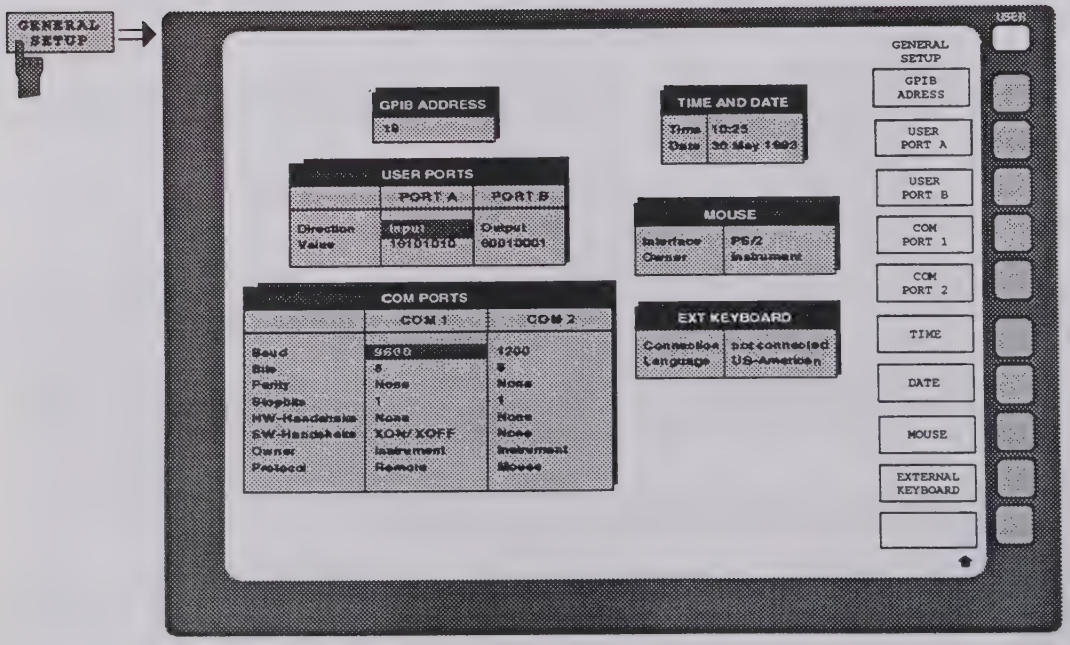
Select SETUP-GENERAL SETUP menu

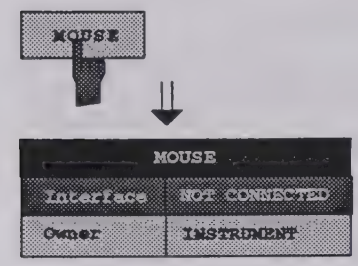
➢ Press the *SETUP* key in the *CONFIGURATION* key group.

The *SETUP* menu is opened.

➢ Press the *GENERAL SETUP* soft key.

The *GENERAL SETUP* sub-menu is opened and the current settings of the general instrument parameters are displayed in tabular form on the display screen.

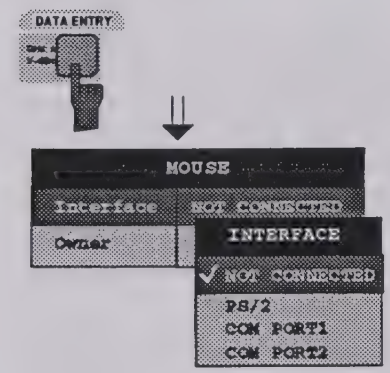




Select interface

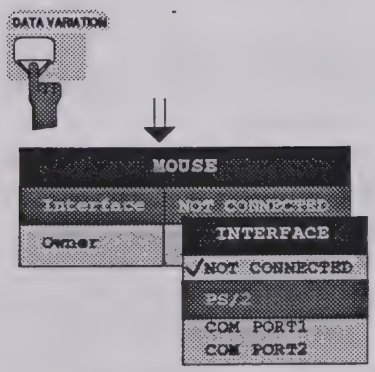
➢ Press the *MOUSE* soft key.

The *INTERFACE* parameter in the *MOUSE* table is marked by the selection bar.

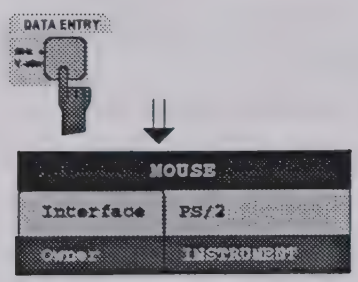


➢ Press one of the units keys.

The *INTERFACE* selection box appears on the display screen. The current state (*NOT CONNECTED*) is indicated by a check mark and the selection bar is in the background.

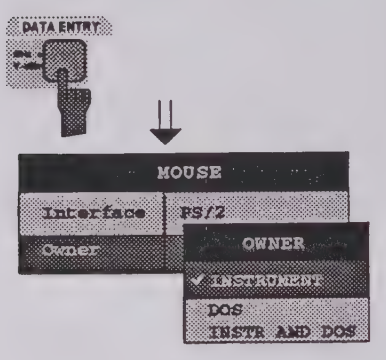


➢ Press the cursor key ⓤ until the entry PS/2 is indicated by the selection bar.



➢ Press one of the units keys.

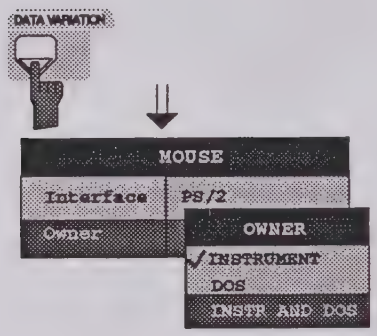
The *INTERFACE* selection box is closed, the setting PS/2 is entered in the MOUSE table and the selection bar is automatically set to the OWNER parameter.



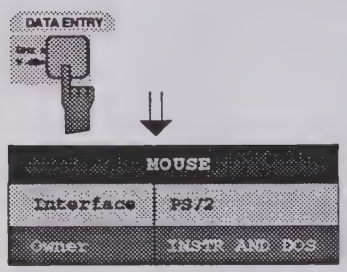
Assign mouse mode

➢ Press one of the units keys.

The *OWNER selection box appears on the display screen. The current state (INSTRUMENT) is indicated by a check mark* and the selection bar is in the background.



➢ Press the cursor key ⓤ until the entry *INSTR AND DOS* is indicated by the selection bar.



➢ Press one of the units keys.

The *OWNER* selection box is closed and the setting *INSTR AND DOS* is entered in the MOUSE table.

The mouse is now installed and is available in both the measurement instrument and DOS modes.

Return to main menu

➢ Press the menu-change key several times.

1.6 Connecting an External Keyboard

Caution:
The keyboard may only be connected when the instrument is switched off (STANDBY). Otherwise, correct operation of the keyboard cannot be guaranteed.

The spectrum analyzer provides an option for connecting an external PC keyboard to the 5-pin DIN connector at the rear panel.

During measurement operations, the keyboard simplifies the input of commentary text, filenames, etc. If the option FSE-B15 (computer function) is installed, the keyboard has the usual DOS-mode functions.

Note: *Using the key combination <ALT><S-Abf> (German keyboard) or <ALT><SYSREQ> (US-keyboard), the representation on the display screen can be rapidly toggled between the measurement instrument and the DOS display formats.*

Appendix E contains a list which describes the assignment of the FSE front-panel key functions to the key codes of the external keyboard as well as special key combinations used for quick operations. Appendix A contains the interface dscription.

The keyboard connection (KEYBOARD) is located on the rear panel.

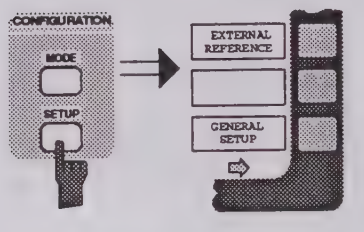
After connecting the keyboard, the connection must be entered into the instrument and the key assignments for measurement instrument operations must be determined.

The configuration takes place in the menu *SETUP-GENERAL SETUP* (key group: *CONFIGURATION, see in Chapter* 2, the section "Preliminary Setup and Interface Configuration").

- The parameter *EXT KEYBOARD CONNECTION* informs the instrument that an external keyboard is connected.
- The parameter *EXT KEYBOARD LANGUAGE* sets the keyboard language definition for measurement instrument operation (*US-AMERICAN* or *GERMAN*).

  Note: *During measurement instrument operation, the key combination <ALT> <F1> can be used to toggle the language definition.*

In the following illustrative example, the instrument is informed that a keyboard has been connected. The GERMAN keyboard definition is selected.



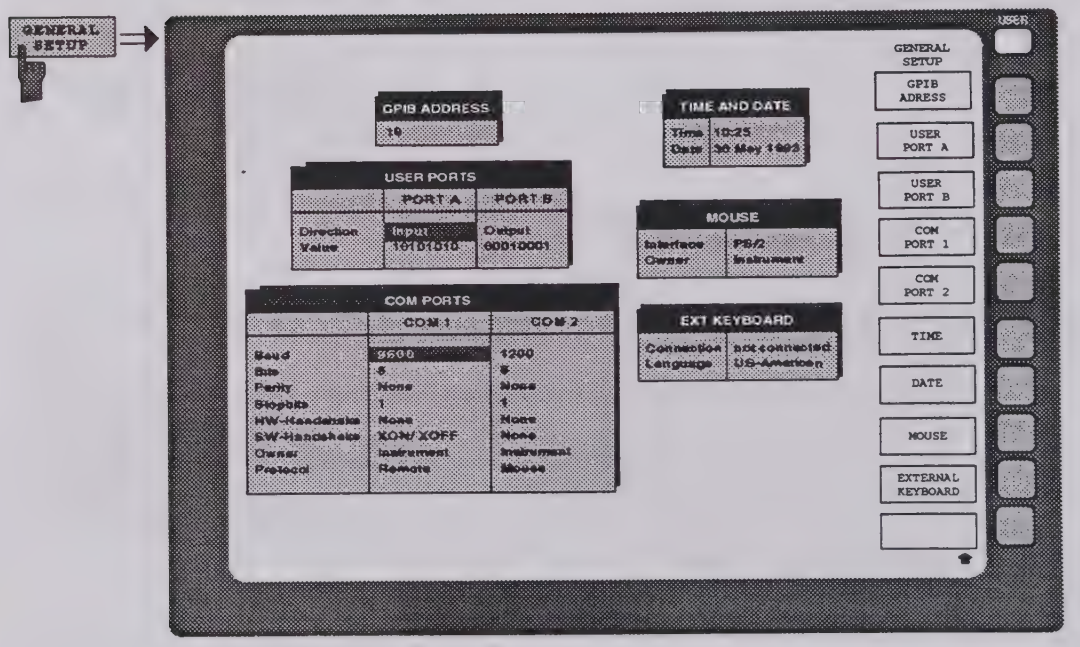
Call SETUP-GENERAL SETUP menu

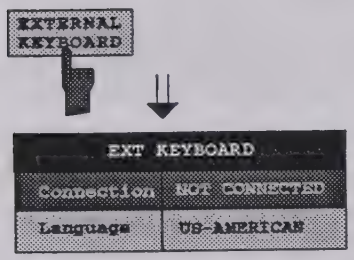
➢ Press the *SETUP* key of the *CONFIGURATION* key group.

The *SETUP* menu is opened.

➢ Press the *GENERAL SETUP* soft key.

The *GENERAL SETUP* sub-menu is opened and the current settings of the general instrument parameters are shown in tabular form on the display screen.

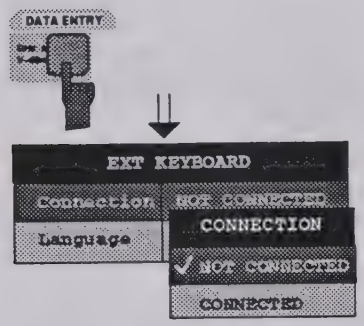




Setup keyboard connection

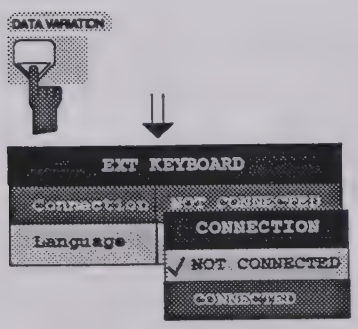
➢ Press the *EXTERNAL KEYBOARD* soft key.

The *CONNECTION* parameter in the *EXT KEYBOARD* table is marked by the selection bar.

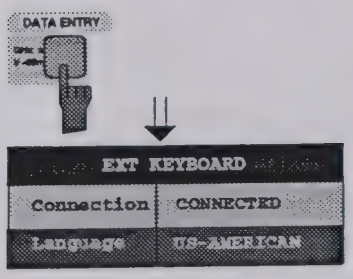


➢ Press one of the units keys.

The *CONNECTION* selection box appears on the display screen. The current state (NOT CONNECTED) is indicated by a check mark and the selection bar is in the background.

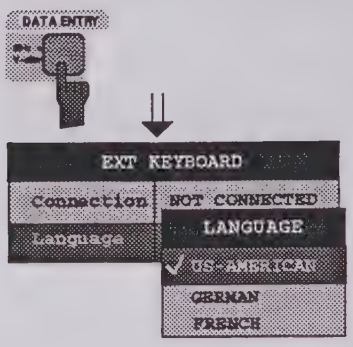


➢ Press the cursor key ⓤ until the *CONNECTED* entry is indicated by the selection bar.



➢ Press one of the units keys.

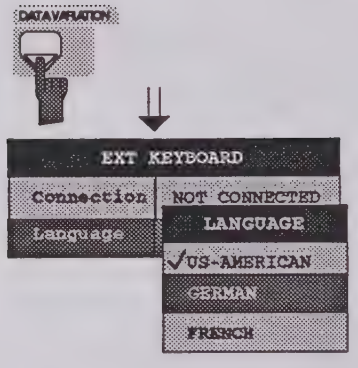
The *CONNECTION* selection box is closed, the setup *CONNECTED* is entered in the table, *EXT KEYBOARD* is entered and the selection bar is automatically set to the *LANGUAGE* parameter.



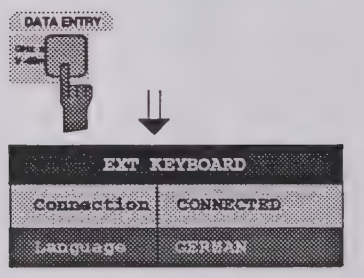
Select German keyboard

➢ Press one of the units keys.

The *LANGUAGE* selection box appears on the display screen. The current state is indicated by a check mark and the selection bar is in the background.



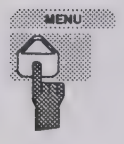
➢ Press the cursor key ⓘ until the *GERMAN entry* is indicated by the selection bar.



➢ Press one of the units keys.

The *LANGUAGE* selection box is closed and the *GERMAN* setting is entered in the *EXT KEYBOARD* table.

Note: *This setting is valid only for the measurement instrument mode. The keyboard assignment in DOS mode is independently set by using the corresponding MS-DOS command.*



Return to MAIN MENU

➢ Press the menu-change key several times.

1.7 Connecting an Output Device

Caution:
The output device may be connected only when the instrument is switched off (STANDBY)

The spectrum analyzer provides an option for connecting up to four different output devices to allow printing a hard copy of the display screen. The output devices supported by the spectrum analyzer can be found in the selection box *DEVICE/LANGUAGE* in the HARDCOPY –SETTINGS DEVICE1/2 menu (see in Chapter 2, the section "Documentation of Measurement Results").
Appendix A contains the interfeace description of the connectors.

The interface connectors are located on the rear panel (see Table 1.7-1).

Table 1.7-1 Interface Connectors for Output Devices

Rear panel interface connectors	LPT	COM1	COM2	<SCPI> IEC625
Name in instrument control	LPT1	COM1	COM2	GPIB1

After connection of the output device to the appropriate interface connector, the configuration of the interface as well as the output device must be entered and the output device must be assigned to the interface.

The configuration of the selected interface (COM1, COM2 or GPIB1) is performed according to the *SETUP-GENERAL SETUP* menu (key group: *CONFIGURATION*, see in Chapter 2, the section "Preliminary Setup and Interface Configuration").

Note: *Interface LPT cannot be configured. If the option FSE-B15, computer function, is installed, LPT1 can be used for printing in both the measurement instrument mode and the DOS mode. However, it can only be used for one mode at a time.*

Interfaces COM1 and COM2

- The parameters *COM PORTS BAUDRATE, BITS, PARITY, STOPBITS, HW/SW-HANDSHAKE* determine the transmission parameters of the interface.

  Note: *The transmission parameters must agree with the specifications of the output device (see the operating manual for the output device).*

- The parameter *COM PORTS PROTOCOL* informs the instrument that an output device is connected to an interface (REMOTE setting).

- The parameter *COM PORTS OWNER* assigns the interface to one or both operational modes.

  Note: *If printing is required in the measurement instrument mode, then this parameter must be set to INSTRUMENT or INSTRUMENT AND DOS. If, on the other hand, printing is required in DOS mode (Option FSE-B15, computer function), then the parameter must be set to DOS or INSTRUMENT AND DOS.*

Interface GPIB1

- The parameter *GPIB ADDRESS* passes the IEC Bus address of the output device to the instrument.

  Note: *If the output device is operated in "listen only" mode, this setup may be omitted.*

The configuration of the connected output device and the assignment to the interface takes place in the *HARDCOPY DEVICE–SETTINGS DEVICE1/2* menu (key group:*HARDCOPY*, see in Chapter 2, the section "Selection and Configuration of the Output Device "). The configuration of up to two output devices (DEVICE1 and DEVICE2) may be entered, of which, at least one must be activated for printing.

- The parameter *DEVICE/LANGUAGE* determines which output device is to be used.

  Note: *During the selection of the printer type, it must be observed that the selected printer type and the connected output device are compatible. In case of doubt, consult the operating manual for the output device.*

- The parameter *CONNECTION* sets the interface which is to be used.

The number of additional parameters which need to be entered depends upon the selected interface and the output device used.

- The parameter *ORIENTATION* sets the page format to horizontal or vertical (portrait).
- The parameter *DEVICE RESET* determines if the output device is to be reset before each print job.
- The parameter *FORMFEED* determines if a formfeed should follow each print job.
- The parameter *PAPER FEED* specifies the paper feeder (single sheet or endless paper).

Table 1.7-2 shows the standard factory settings for the two output devices.

The standard factory settings for *DEVICE 1* correspond to an output device controlled by the command language HPGL, typically, a plotter connected to the IEC-Bus interface.

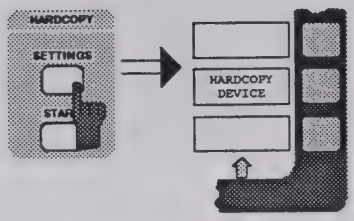
The standard factory settings for *DEVICE 2* correspond to a Epson printer (and compatible) connected to the parallel interface LPT.

Table 1.7-2 Factory settings for *DEVICE 1* and *DEVICE 2* in the *HARDCOPY-DEVICE SETTINGS* menu.

Parameter	Parameter Name	*DEVICE 1 Settings*	*DEVICE 2 Settings*
Output Device/Descriptive Language	DEVICE/LANGUAGE	HPGL	EPSON 24
Output Channel	CONNECTION	GPIB 1	LPT
IEC Bus Address	GPIB ADDRESS	4	---
Paper Format	ORIENTATION	PORTRAIT	PORTRAIT
Output Device Reset	DEVICE RESET	OFF	OFF
Formfeed	FORMFEED	OFF	ON
Paperfeed	PAPERFEED	MANUAL	MANUAL

In the following illustrative examples, a Postscript printer is connected to the LPT interface.

Note: *Interface LPT cannot be configured. The configuration of the other interfaces (COM1, COM2 or GPIB1) is performed according to the SETUP-GENERAL SETUP menu (key group: CONFIGURATION, see in Chapter 2, the section "Preliminary Setup and Interface Configuration").*



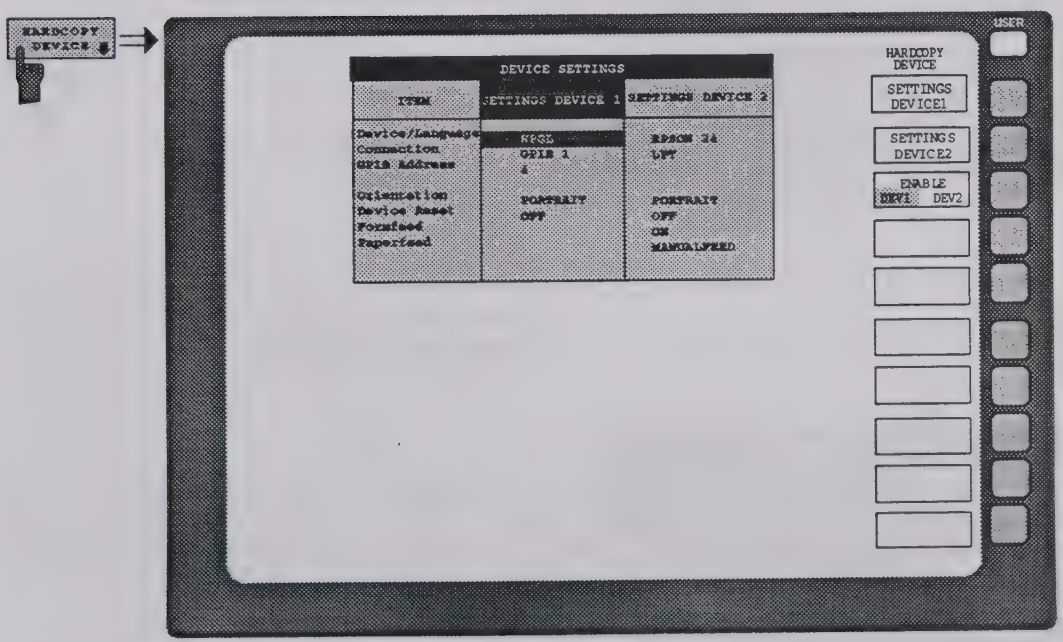
Configure printer and connect to interface

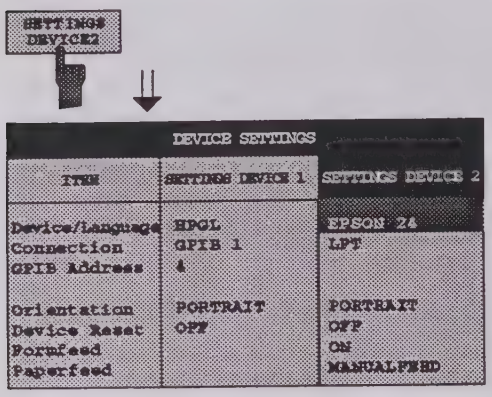
➢ Press the *SETTINGS* key of the *HARDCOPY* key group.

The *SETTINGS* menu is opened.

➢ Press the *HARDCOPY DEVICE* soft key

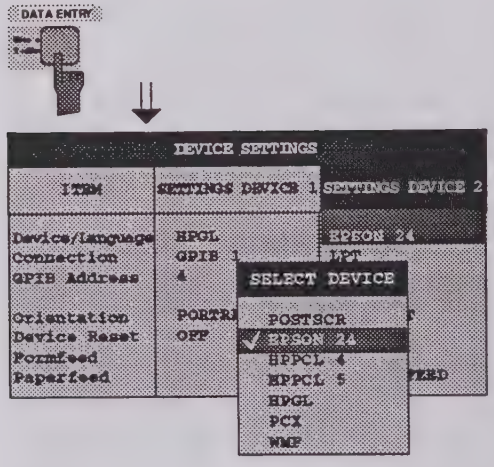
The *HARDCOPY DEVICE* sub-menu is opened and the current settings for the two possible output devices are displayed in tabular form on the display screen.





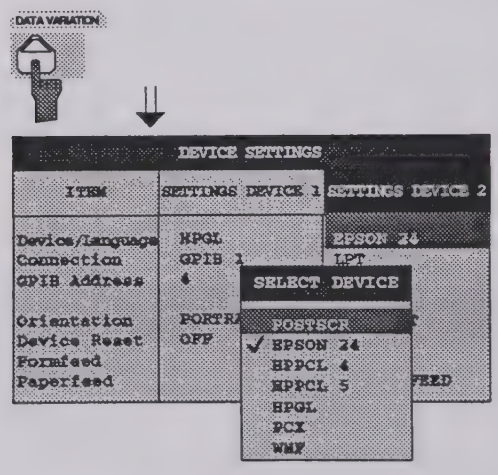
➢ Press the *SETTINGS DEVICE2* softkey.

The current selection in the first line of the table column *SETTINGS DEVICE2* is marked by the selection bar.

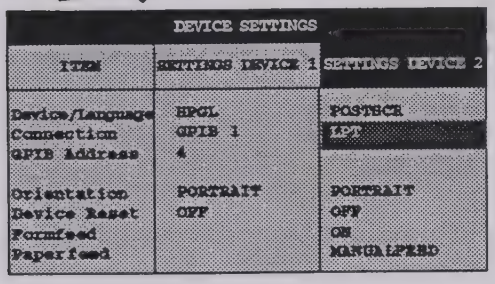


➢ Press one of the units keys.

The *SELECT DEVICE* selection box appears on the display screen. The current selection is indicated by a check mark and the selection bar is in the background.



➢ Press the cursor key ⓘ until the *POSTSCR* entry is indicated by the selection bar.



➢ Press one of the units keys.

The *SELECT DEVICE* selection box is closed and the *POSTSCR* setting is entered in the table column *SETTINGS DEVICE2*. The selection bar now indicates the current entry in the next row of the table.

Note: *The CONNECTION parameter is set to LPT at the factory and, therefore, must not be changed. The selection of the printer type automatically sets the parameters ORIENTATION, DEVICE RESET, FORM FEED and PAPER LENGTH to values which correspond to a standard mode of operation with this output device.*

Activate printer

➢ Press the *ENABLE* soft key until DEV2 in the second soft key line is selected.

Return to main menu

➢ Press the menu-change key several times.

1.8 Firmware Update

The installation of a new firmware version can be performed using the built-in diskette drive and does not require opening the spectrum analyzer. The deliverable items contained in the Firmware Update Kit and the installation program call procedure may be found in the documentation accompanying the kit. The installation program then leads the user through the remaining steps of an update.

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1.9 Options

1.9.1 Option FSE-B17 – Second IEC/IEEE Interface

Besides the FSE external devices can also be controlled via the IEC/IEEE bus using the optional 2nd bus interface FSE-B17 and the computer function for FSE (option FSE-B15). The interface software permits IEC/IEEE-bus commands to be included in user programs.

1.9.1.1 Installing the software

1. The operating software is already installed and need not be loaded from the driver diskettes which serve as backup diskettes.
2. The driver GPIB.COM must be loaded on the start-up of DOS. For this to take place, the line DEVICE = C:\AT-GPIB\GPIB.COM has to be entered in the file C:\CONFIG.SYS. If the option is factory fitted, this line will have been entered in the factory.
3. The configuration of the card can be modified with the program C:\AT-GPIB\IBCONF.EXE. The following parameters may not be changed:

   ```
   Enable Auto Serial Polling .. No
   Base I/O Address ............ 02C0h
   Interrupt Level ............. 7
   DMA Channel ................. 5
   ```

   For further parameters, refer to manual for the card.
4. The parameters of units connected are also set with the program IBCONF.EXE. The logic designation for FSE is preset to DEV1 and the address to 20. For further equipment refer to manual for the card.

   Note: *Ensure that the names assigned to the connected units are not the same as the directory names under DOS.*

1.9.1.2 Operation

The second IEC/IEEE-bus interface corresponds physically to that of FSE (see appendix A).
If the FSE is to be controlled via the IEC/IEEE bus, a bus cable must be plugged to both bus connectors.

The interface can be driven under DOS/WINDOWS by R&S software (FSE-K3, Order No. 1057.2996.02, etc.) or by user-written software. The handling of IEC/IEEE-bus commands in user programs is described in the manual for the card.

The files for DOS in the computer function are in directory C:\AT-GPIB, those for WINDOWS in directory C:\AT-GPIBW .

Note: *The program IBIC.EXE (see manual for the card) may not be used for controlling the FSE (measuring unit section); however external units can be controlled via the bus.*

2 Manual Operation

2.1 Measurement Examples

This section describes a typical, simple measurement task for a spectrum analyzer. In the following description, each step is explained in detail using the FSE so that the instrument can be immediately used without the need for learning all of the available functions. The described measurement applications are:

- Measurement of the level and frequency of a sine wave signal.
- Measurement of harmonics.
- Measurement of third order intermodulation and determination of the intercept point.
- Zero span measurement of a pulsed signal.

All of the following examples assume the standard settings for the analyzer. These are set with the *PRESET* key in the *SYSTEM* key field. The most important standard settings are shown in Table 2.1-1. A complete listing of standard settings can be found in Chapter 2.4.

Table 2.1-1 Important PRESET settings

Parameter	Parameter name	Setting		
		FSEA	FSEB	FSEM
Mode	Mode	analyzer	analyzer	analyzer
Center frequency	Center Frequency	1,75 GHz	3,5 GHz	13,25 GHz
Active Freq. Meas. Range	Span	3,5 GHz	7 GHz	26,5 GHz
Reference Level	Ref Level	– 20 dBm	– 20 dBm	– 20 dBm
RF Attenuation	RF ATT	10 dB	10 dB	10 dB
Level Display Range	Level Range	100 dB	100 dB	100 dB
Resolution Bandwidth	Res Bw	3 MHz	3 MHz	3 MHz
Video Bandwidth	Video Bw	3 MHz	3 MHz	3 MHz
Sweep Time	Sweep Time	5 ms	5 ms	100 ms
Trigger	Trigger	free run	free run	free run

2.1.1 Level and Frequency Measurements

2.1.1.1 Measurement Task

The determination of the level and frequency of a signal is one of the most frequently encountered measurement tasks typically performed by a spectrum analyzer. Usually, for the measurement of an unknown signal, the PRESET settings are initially selected. If levels above +30 dBm are expected or possible, then a power attenuator must be inserted ahead of the analyzer input. Without attenuation, these signal levels might damage or destroy the input attenuator or the input mixer.

2.1.1.2 Important Spectrum Analyzer Functions

Important parameters for level and frequency measurements are the settings for the *CENTER FREQUENCY*, the selection of the active measurement frequency range (*SPAN*) and the *MARKER* functions.

2.1.1.3 Sweep, Level and Frequency Measurements – Example 1

In this example, a signal with a frequency of 200 MHz and a level of -10 dBm are applied to the RF INPUT of the analyzer. The selection of the center frequency and the active frequency range takes place manually.

The necessary setup functions are performed almost without exception by the fixed-function keys. The menus which appear with a key can, for the most part, be ignored. In this manner, fast, key-oriented operation is possible.

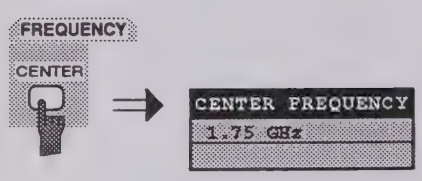
The following setup steps are performed:

1. Reset the instrument.
2. Apply the test signal.
3. Set the center frequency to 200 MHz.
4. Reduce the active measurement frequency range (SPAN) to 1 MHz.
5. Measure the level and frequency using the marker.
6. Optimize the measurement dynamic range and reduce the level measurement error.
7. Measure the frequency with the internal frequency counter

1. Reset the instrument.

➢ Press the *PRESET* key.

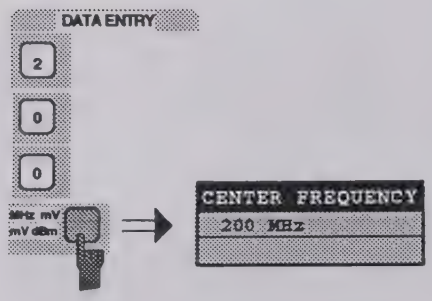
2. Connect the test signal to the RF INPUT located on the instrument front panel.



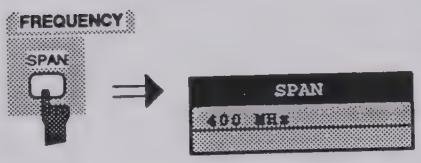
3. Set the center frequency to 200 MHz.

➢ Press the *CENTER* key in the *FREQUENCY* key field.

The input field for center frequency appears on the display screen.

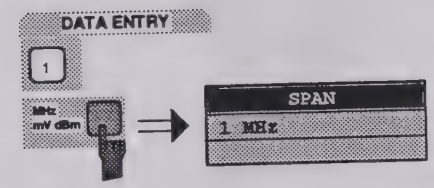


➢ Enter *200* via the numeric keypad and terminate with the *MHz* key.



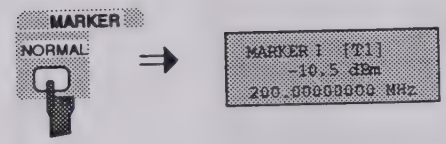
4. *Reduce the measurement frequency range (SPAN) to 1 MHz.*

➢ Press the *SPAN* key in the *FREQUENCY* key field.



➢ Enter *1* via the numeric keypad and terminate with the *MHz* key.

Note: *In conjunction with the change in measurement frequency range (SPAN), the resolution bandwidth (RES BW), video bandwidth (VIDEO BW) and sweep time (SWEEP TIME) are set to new values since they are defined as coupled functions in the standard PRESET settings.*



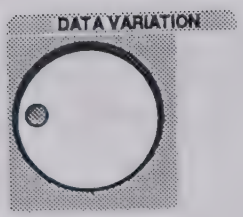
5. *Measure level and frequency using the marker and read the resulting values on the display screen.*

➢ Press the *NORMAL* key in the *MARKER* key field.

The marker jumps to the largest signal peak shown on the display screen.

Note: *When the marker is switched on for the first time, it automatically performs the PEAK SEARCH function as demonstrated in this example.*
If a marker was already active, the SEARCH key in the MARKER key field must be pressed in order to set the currently active marker to the displayed signal maximum.

The level and frequency measured by the marker can be read in the marker field at the upper edge of the display screen. (see Figure 2.1-1).



➢ Using the roll-key, the marker can be moved along the measured curve.

The corresponding level and frequency values appear in the marker field.

Figure 2.1-1 shows the measured curve on the display screen over a 1 MHz range as well as the marker level and frequency values.

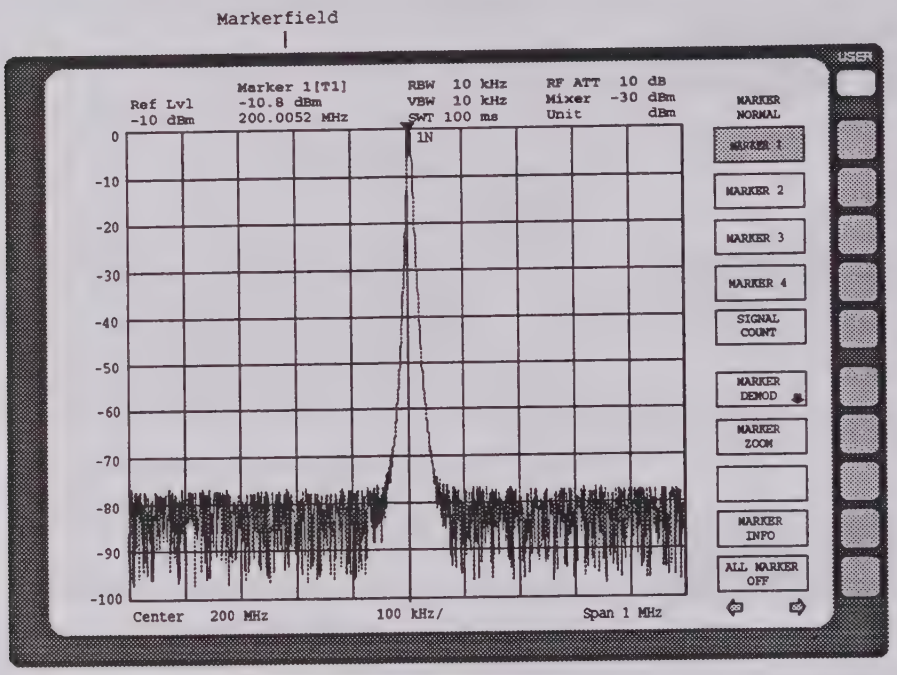
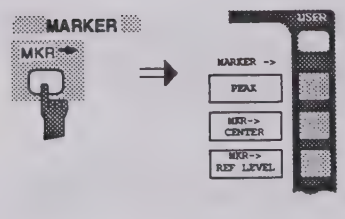


Fig. 2.1-1 200-MHz signal. The measured values are displayed in the marker field.

At low signal-to-noise ratios, the level measurement accuracy can be improved by an optimum selection of the FSE parameters. The accuracy of the frequency display can also be enhanced by applying the internal frequency counter.



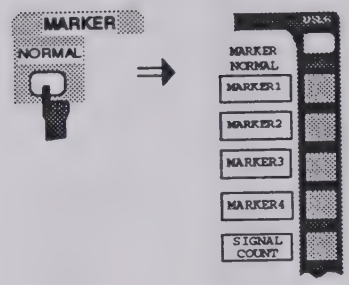
6. Optimize the dynamic range and reduce the level measurement error.

➢ Press the *MKR→* key in the *MARKER* key field.

The *MARKER-MKR→* menu is opened.

➢ Press *MKR → REF LEVEL* soft key.

The reference level (REF LEVEL) is reduced to the signal level.



7: Determine the exact frequency with the internal frequency counter.

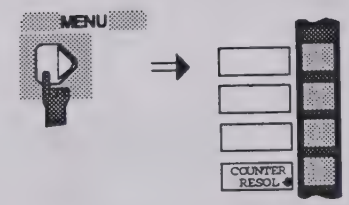
Note: *The frequency counter measures the frequency of the marked signal with the selected counter resolution and at the accuracy of the internal frequency reference. A frequency measurement made using the marker is, however, limited by the number of horizontal display points and the applicable resolution bandwidth.*

➢ Press the *NORMAL* key in the *MARKER* key field.

The *MARKER NORMAL* menu is opened.

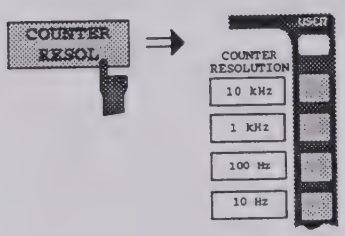
➢ Press the *SIGNAL COUNT* soft key.

The internal frequency counter is now active and measures the signal frequency with the PRESET resolution. The resolution is to be increased to 10 Hz.



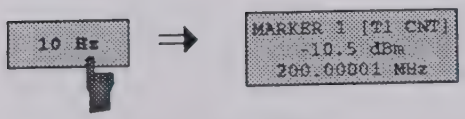
➢ Press the menu change key ▷.

The supplementary menu is opened.



➢ Press the *COUNTER RESOL* soft key.

The *COUNTER RESOLUTION* sub-menu is opened.



➢ Press the *10 Hz* soft key.

The desired frequency resolution (10 Hz) is now selected.

In the marker field, the item [CNT] indicates that the counter is active (see Fig. 2.1-2).

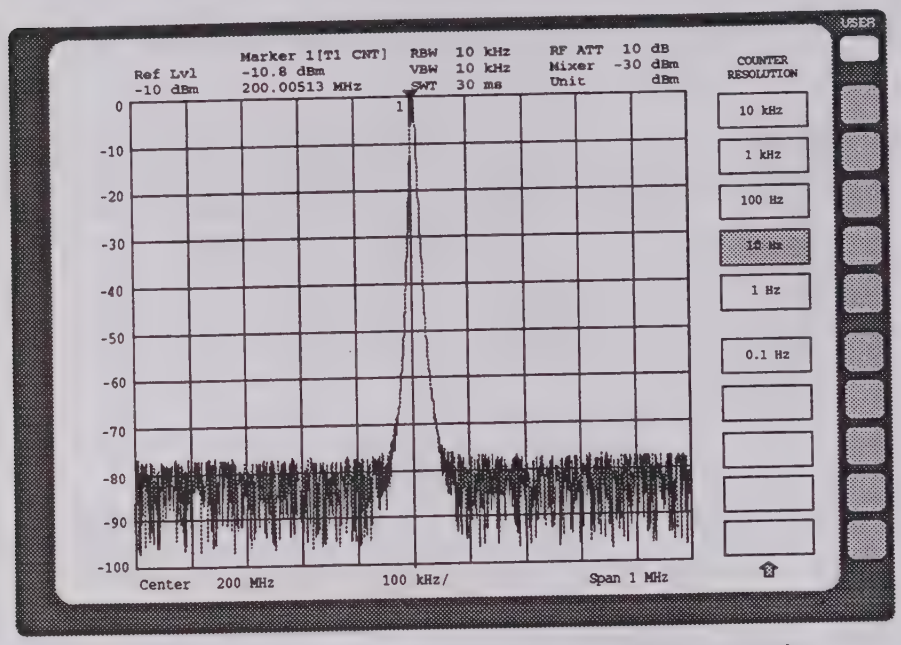


Figure 2.1-2 Frequency measurement using the internal frequency counter.

2.1.1.4 Sweep, Level and Frequency Measurements – Example 2

The zoom function (*MARKER ZOOM*) operates much faster than the manual input of center frequency and measurement frequency range, and permits the measurement frequency range displayed on the screen to be as narrow as desired.

As in Example 1, a signal with a frequency of 200 MHz and a level of -10 dBm is applied to the analyzer RF INPUT.

The following setup steps are performed:

1. Reset the instrument.
2. Apply the signal.
3. Zoom in on the signal.
4. Measure the level and frequency with the marker.
5. Optimize the dynamic range and reduce the level measurement error.
6. Measure the frequency with the internal frequency counter.

Steps 1 to 2 and 4 to 6 correspond to steps 1 to 2 and 5 to 7, respectively, of Example 1. Step 3 replaces the manual input of center frequency and measurement frequency range. (steps 3 and 4).

See steps 1 and 2 of example 1

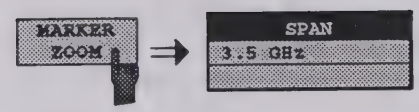
1. Reset the instrument to standard settings.

2. Connect the test signal to the analyzer RF INPUT.

3. Zoom in on the signal.

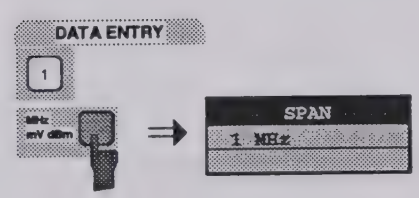
➢ Press the *NORMAL* key in the *MARKER key field*.

The marker moves to the largest signal displayed on the screen. In this example, it is the signal at 200 MHz. (PEAK SEARCH function, see step 5 in Example 1).



➢ Press the *MARKER ZOOM* soft key.

The input field for the measurement frequency range appears on the display screen.



➢ Enter 1 via the numeric keypad and terminate with the *MHz* key.

After entry of the measurement frequency range, the marked signal is counted and then used as the new center frequency. At the same time, the entered measurement frequency range is set.

Note: *In conjunction with the active measurement frequency range (SPAN) change, the resolution bandwidth (RES BW), video bandwidth (VIDEO BW) and sweep time (SWEEP TIME) are also set to new values since they are defined as coupled functions in the standard PRESET settings.*

See steps 5 to 7 of example 1:

4. Read the values for level and frequency as measured by the marker.

5. Optimize the dynamic range and reduce the level measurement error.

6. Determine the frequency with the internal frequency counter.

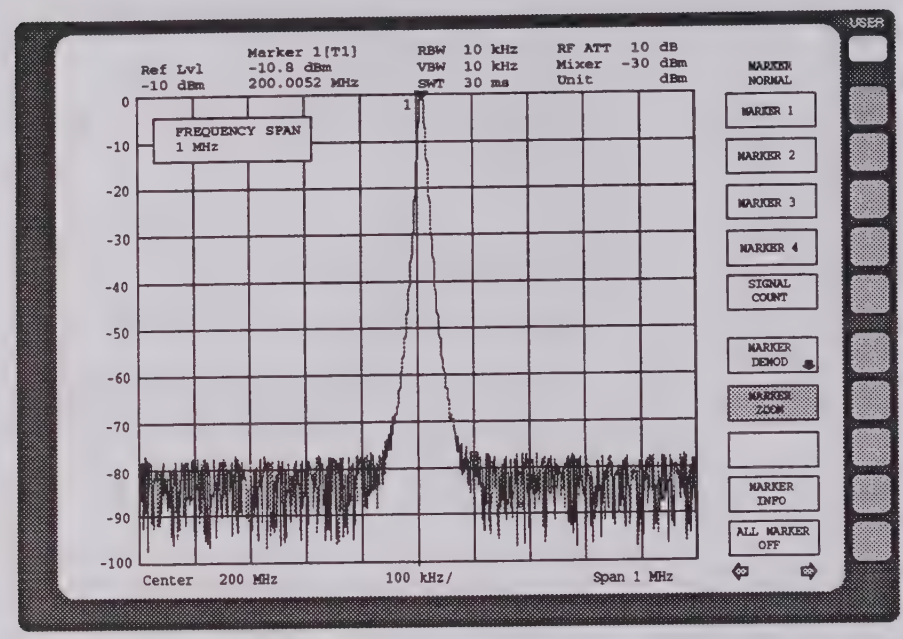


Figure 2.1-3 The The MARKER ZOOM function requires the entry of the measurement frequency range (span)

2.1.1.5 Level Measurement Accuracy

The level measurement accuracy of an analyzer is influenced by the following parameters:

- RF attenuator (*RF-ATT*)
- IF amplification
- Resolution bandwidth (*RES BW*)
- Display range (*LEVEL RANGE*)
- Display linearity (*SCALE FIDELITY*)

The error in a level measurement for the FSE is < 1 dB for frequencies up to 1 GHz and < 1.5 dB for frequencies from 1 GHz to 3.5 GHz. This specification includes all of the above mentioned influential factors. The frequency characteristics of the pertinent modules (RF divider, front end) are stored individually in memory on each module. The FSE initializing routines read out the corresponding values during execution immediately after the analyzer is turned on and corrects the frequency characteristics during the sweep. Any errors in the attenuation settings, the filter bandwidth or the video rectifier are corrected after calling the built-in calibration routines. For calibration purposes, the FSE has an internal 120 MHz calibration source which is switched internally to the RF INPUT.
The measurement accuracy is guaranteed only after running the calibration routines. It should be noted, however, that the individual parameters are so stable that a calibration need only be performed, after approximately 15 minutes warm-up time, for larger temperature variations. Normally, a weekly calibration is more than adequate.

2.1.2 Measurement of Harmonic Separation

2.1.2.1 Measurement Task

The measurement of signal harmonics is a frequently occurring task which can be optimally performed by a spectrum analyzer. In general, all signals will contain harmonics to some degree. Harmonics are especially critical in high-power transmitters, e.g., in radio transmitters, where a significant radiated harmonic component may interfere with the reception of other radio services. Generally, non-linear device characteristics create harmonics which are often selectively reduced through the use of low-pass filters. Since the spectrum analyzer also has non-linear characteristics, e.g., at the first mixer, it is necessary to exercise caution during a measurement to insure that the spurious harmonics generated by the analyzer do not influence the measurement results. If necessary, the fundamental frequency must be selectively attenuated with respect to the harmonics by insertion of an appropriate high-pass filter.

For harmonic-content measurements, the achievable measurement dynamic range is dependent upon the k2 intercept of the spectrum analyzer. The k2 intercept point is defined as the fictitious first-mixer input level where the levels of the first harmonic and of the fundamental frequency are equal. In practice, this level cannot be applied to the mixer since, to do so, would cause its destruction. However, using the k2 intercept point concept, the achievable measurement dynamic range for the harmonics of a Unit Under Test (UUT) can be calculated with relative simplicity.

As can be seen in Fig. 2.1-4, the harmonic level is reduced by 20 dB when the level at the fundamental frequency is reduced by 10 dB.

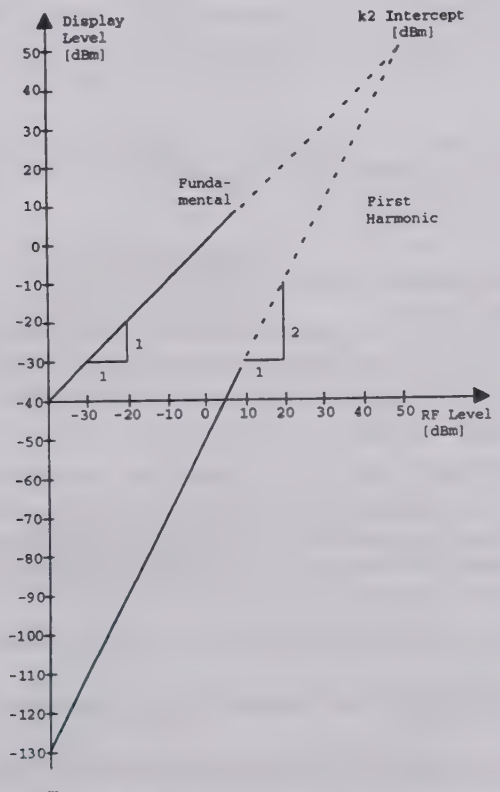


Figure 2.1-4 Theoretical display curve of fundamental and first harmonic with a k2 intercept of 50 dBm.

From the linear equations and the given intercept point, the following formula can be derived for the achievable harmonic separation a_{k2} in dB:

$$a_{k2} = IP2 - P_e \qquad (1)$$

a_{k2} = harmonic separation
P_e = mixer level/dBm
IP2 = k2 intercept point

The formula for the internally produced level P_1 at the first harmonic in dBm is:

$$P_1 = 2 \bullet P_e - IP2 \qquad (2)$$

The lower harmonic measurement limit is dictated by the noise figure of the spectrum analyzer. Through adequate averaging with the video filter, the UUT harmonic level which is to be measured should be at least 4 dB over the noise figure so that the measurement error caused by the input noise is less than 1 dB.

From the above, the following rules for the measurement of large harmonic separations can be derived:

- Select an IF bandwidth as narrow as possible in order to reduce the noise figure.
- Select the RF attenuation as high as required so that the necessary harmonic separation can still be measured.

Note: *The mixer amplitude is the applied RF level reduced by the selected RF attenuation. The low distortion (LOW DISTORTION function) mode of the analyzer automatically sets the optimum RF attenuation for the best harmonic separation.*

The maximum harmonic separation is achieved when the harmonics level is equal to the inherent noise level of the receiver. The corresponding level at the mixer according to (2) is:

$$P_e[dBm] = \frac{P_{Rausch} / dBm + IP2}{2}$$

For a 30 Hz resolution bandwidth, (noise level < -140 dB, IP2 = 50 dBm), this level is -45 dBm. Therefore, according to (1) , the maximum measurable harmonic separation is 95 dB less 4 dB minimum signal-to-noise ratio.

2.1.2.2 Important Spectrum Analyzer Functions

In addition to frequency and level settings, the harmonic separation measurement requires, above all, the delta markers. Also, the MRK→ CF STEP SIZE function (marker frequency = center frequency step-width) is used in order to quickly measure the individual harmonics with the cursor keys.

There are several methods to measure harmonic content:

- The measurement of fundamental and harmonic signals in one measurement frequency range.
- The individual measurement of the harmonic separation in a narrow measurement frequency range. This method is preferred when high harmonic separation is to be measured (requires large dynamic range and, thus, narrow resolution bandwidth) or the frequency of the fundamental is very high, i.e., a very wide measurement frequency range is necessary.
- The measurement of fundamental and harmonics in two independent windows on the display screen (SPLIT SCREEN mode).

Example 1 describes the measurement of fundamental and harmonics in one measurement frequency range.

Example 2 describes the measurement of harmonic separation in separate measurement frequency ranges.

Example 3 shows the measurement of fundamental and harmonics in two independent windows on the display screen.

2.1.2.3 Measurement Procedure - Harmonic Separation – Example 1

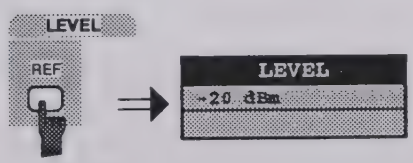
The analyzer 10 MHz reference signal is used at the input signal. The connector EXT REF IN/OUT on the rear panel is connected to the analyzer front-panel RF INPUT. Since the output level is 7 dBm, the reference level must be set to 10 dBm.

The following setup steps are performed:

1. Reset the instrument.
2. Set the reference level to 10 dBm.
3. Connect the rear-panel 10 MHz reference signal to the analyzer input RF INPUT.
4. Set the start frequency to 5 MHz.
5. Set the stop frequency to 55 MHz.
6. Smooth the displayed noise with the video bandwidth.
7. Measure the fundamental signal with the marker.
8. Measure the harmonic separation with the delta marker.
9. Measure the separation of remaining harmonics.

1. Reset the analyzer.

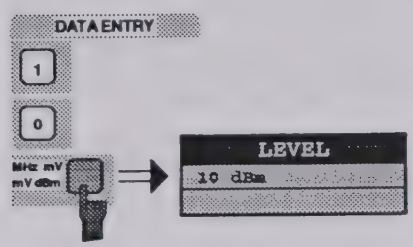
➢ Press the *PRESET key.*



2. Set the reference level to 10 dBm.

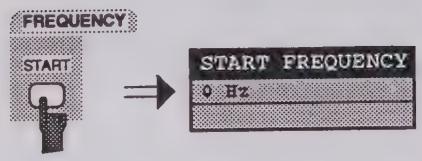
➢ Press *REF* key in the *LEVEL* key field.

The entry field for the reference level appears on the display screen.



➢ Enter 10 via the numeric keypad and terminate with the *dBm* key.

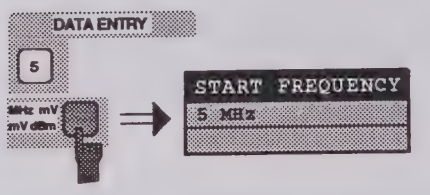
3. Connect the 10 MHz-reference signal (output EXT REF IN/OUT) to the analyzer RF INPUT.



4. Set the start frequency to 5 MHz

➢ Press the *START* key in the *FREQUENCY* key field.

The entry window for the start frequency appears on the display screen.

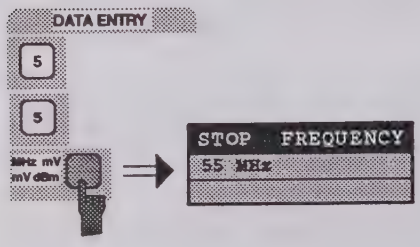


➢ Enter 5 via the numeric keypad and terminate with the *MHz* key.

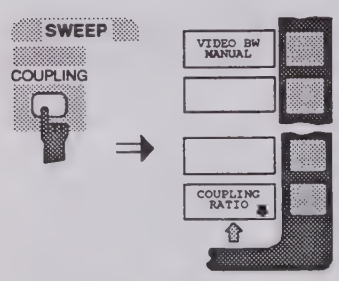
5. Set the stop frequency to 55 MHz

➢ Press the *STOP* key in the *FREQUENCY* key field.

The entry window for the stop frequency appears on the display screen.



➢ Enter 55 via the numeric keypad and terminate with the *MHz* key.

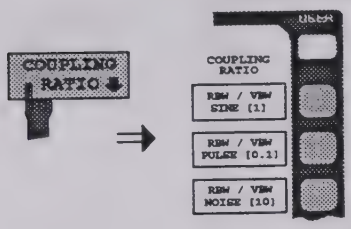


6. Smooth the displayed noise with the video bandwidth

➢ Press the *COUPLING* key in the *SWEEP* key field.

The *SWEEP-COUPLING* menu is opened.

The video bandwidth can now be either automatically coupled to the resolution bandwidth or manually entered.



either:

Automatic coupling of the video bandwidth to the measurement frequency range

➢ Press the *COUPLING RATIO* soft key.

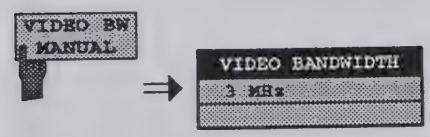
The sub-menu for setting the automatic coupling of bandwidths to the measurement frequency range is opened.

➢ Press the *RBW / VBW NOISE* soft key *[10]*.

The video bandwidth is set to a factor of 10 less than the resolution bandwidth. This smoothes the displayed noise.

➢ Press the menu change key ⌂ .

The *COUPLING RATIO* submenu is closed.

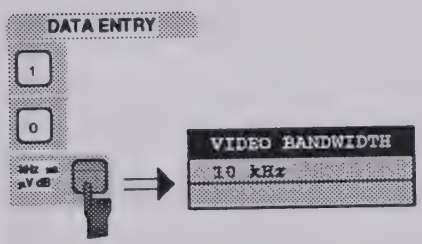


or:

Manual input of the video bandwidth

➢ Press the *VIDEO BW MANUAL soft key.*

The entry field for the video bandwidth appears on the display screen.



➢ Enter 10 via the numeric keypad and terminate with the *kHz* key.

The analyzer displays the fundamental as well as the first to third harmonics (see Fig. 2.1-5).

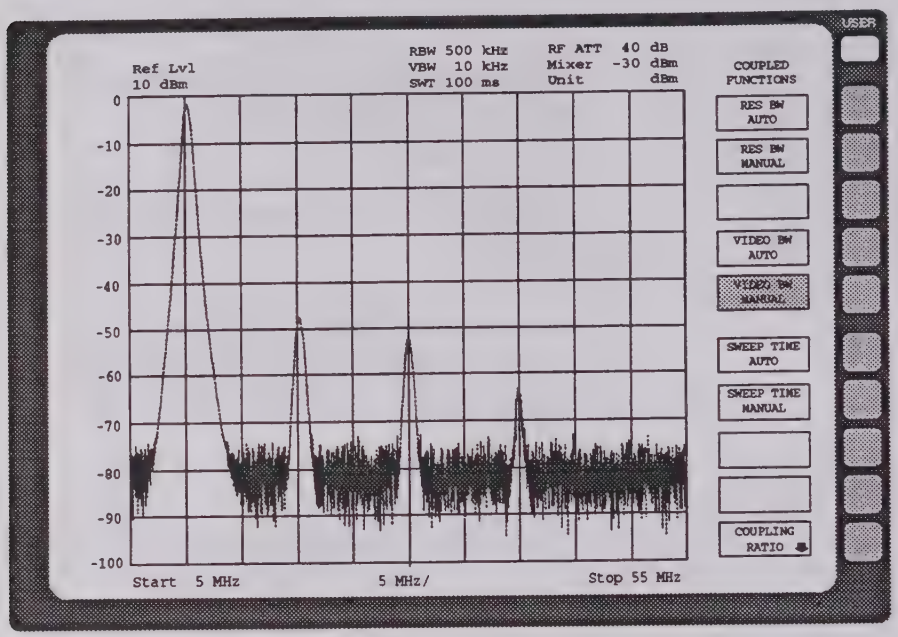


Figure 2.1-5 The 10-MHz-fundamental and harmonics to 55 MHz

7. Measure the fundamental with the marker.

➢ Press the *NORMAL* key in *MARKER* key field.

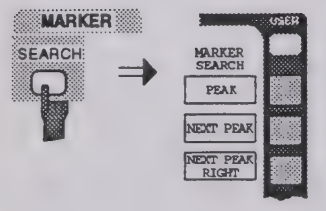
The marker appears at the fundamental peak (see also level and frequency measurement step 5 of the PEAK SEARCH function).

The measured values can be read at the upper left of the display screen.

8: Activate the delta marker and measure the harmonic separation

➢ Press the *DELTA* key in the *MARKER* key field

The delta marker is active and appears on the fundamental.



➢ Press the *SEARCH* key in the *MARKER* key group .

The *SEARCH-MARKER* menu is opened.

➢ Press the *NEXT PEAK RIGHT* soft key.

The delta marker jumps to the first harmonic and measures the difference between the harmonic and the fundamental. The measured values can be read at the upper left of the display screen. In this example, the harmonic separation is approx. 40 dB (see Fig. 2.1-6).

9. Measure the separation of additional harmonics

➢ Press the *NEXT PEAK RIGHT* soft key.

The delta marker jumps to the next highest harmonic. The measured value can be read as before.

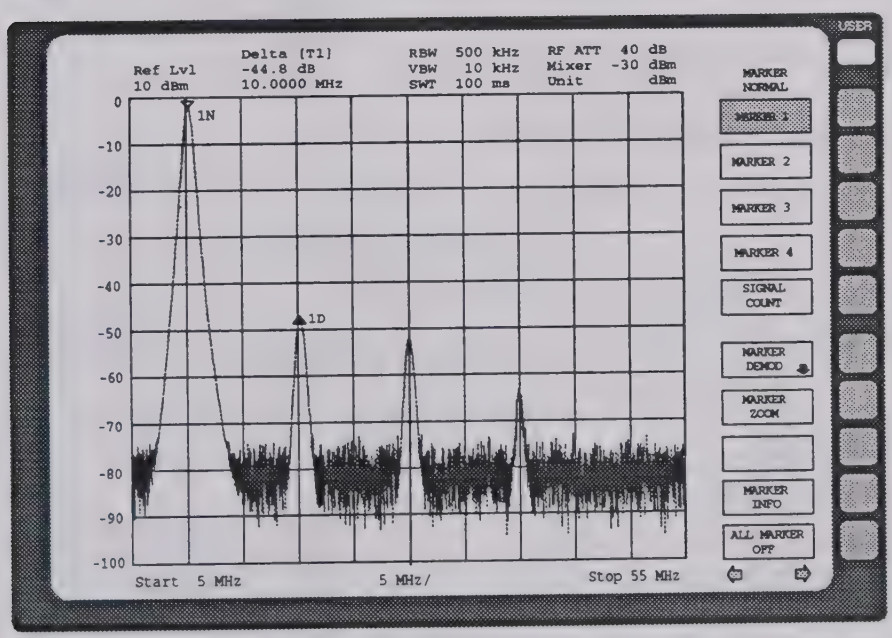


Figure 2.1-6 First harmonic separation: approx. 40 dB referred to the fundamental

2.1.2.4 Measurement Procedure - Harmonic Separation – Example 2

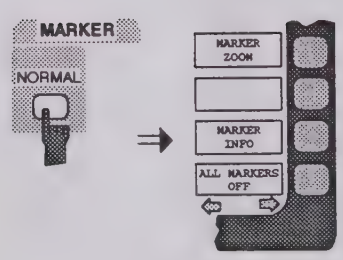
In example 2, the fundamental frequency of the test signal and the separation of the individual harmonics are measured. The reference to the fundamental is established with the REFERENCE FIXED marker, and the movement from harmonic to harmonic is performed with the MKR→ CF STEP SIZE and step keys. This method is recommended when the highest dynamic range is to be achieved.

The following measurement steps are carried out:

1. Reset the instrument.
2. Set the reference level to 10 dBm.
3. Connect the rear-panel 10 MHz reference signal (connector EXT REF IN/OUT) to the analyzer input RF INPUT.
4. Set the start frequency to 5 MHz.
5. Set the stop frequency to 55 MHz.
6. Smooth the displayed noise with the video bandwidth.
7. Measure the fundamental signal with the marker.
8. Reduce the measurement frequency range (ZOOM function):
9. Set the frequency step size to the fundamental frequency.
10. Save the reference value (REFERENCE FIXED)
11. Measure the separation to the first harmonic.
12. Measure the separations to the remaining harmonics.

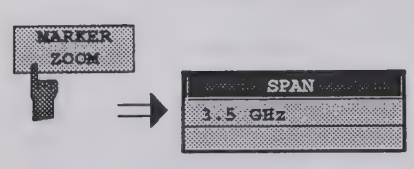
Set the analyzer according to Example 1 up to and including "Measure the fundamental with the marker" (steps 1 to 7).

8. Reduce the measurement frequency range.



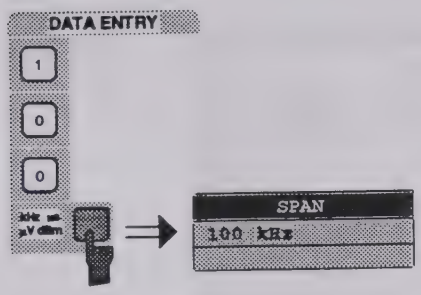
➢ Press the *NORMAL* key in the *MARKER key field* .

The *MARKER-NORMAL* menu is opened.



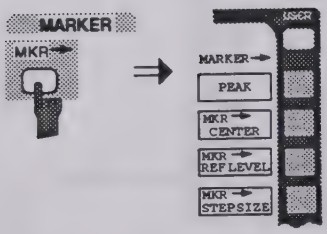
➢ Press the *MARKER ZOOM* soft key.

The entry field for the measurement frequency range appears on the display screen.



➢ Enter 100 via the numeric keypad and terminate with the *kHz* key.

9. Set the frequency step size to the fundamental frequency



➢ Press the *MKR →* key in the *MARKER* key field

The *MARKER-MKR →* menu is opened.

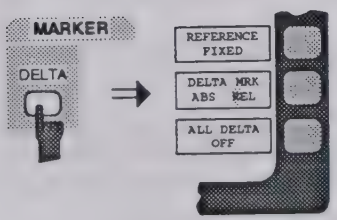
➢ Press the *PEAK* soft key.

The marker appears at peak of the fundamental signal.

➢ Press the *MKR →* *CF STEP SIZE* soft key.

The step size used when setting the center frequency with the cursor keys is set equal to the marker frequency.

10. Fix reference value



➢ Press the *DELTA* key in the *MARKER* key field.

The *DELTA-MARKER* menu is opened.

➢ Press the *REFERENCE FIXED* soft key.

The position of the marker is now a curve-independent reference for the delta measurement, even when the actual reference point is not visible on the display screen.

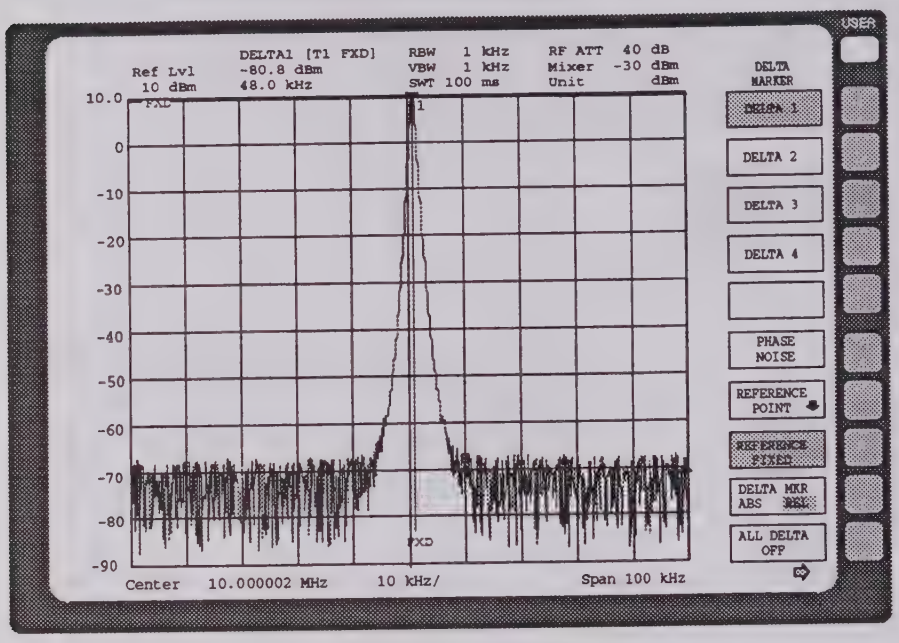
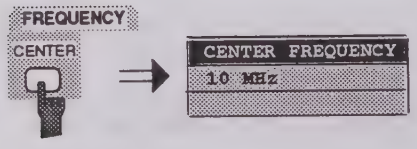


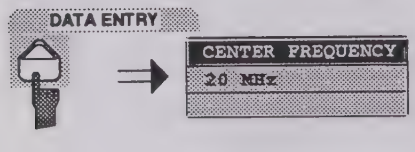
Figure 2.1-7 Fundamental with REFERENCE FIXED marker



11. Measure the harmonic

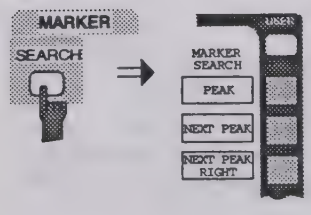
➢ Press the *CENTER* key in the *FREQUENCY* key field.

The entry field for the center frequency appears on the display screen.



➢ Press the cursor key ⌓ in the *DATA ENTRY* key field.

The center frequency is increased by one step (= fundamental frequency).



➢ Press the *SEARCH* key in the *MARKER* key field.

The *SEARCH-MARKER* menu is opened.

➢ Press the *PEAK* softkey.

The delta marker appears at the first harmonic and measures the separation from harmonic to fundamental. The measured value is displayed in the marker field at the upper left of the display screen (see Fig. 2.1-8).

12. Measure the separation of additional harmonics

➢ Repeat all of step 11.

The center frequency is once again increased by the frequency of the fundamental. The delta marker thus appears at the next harmonic.

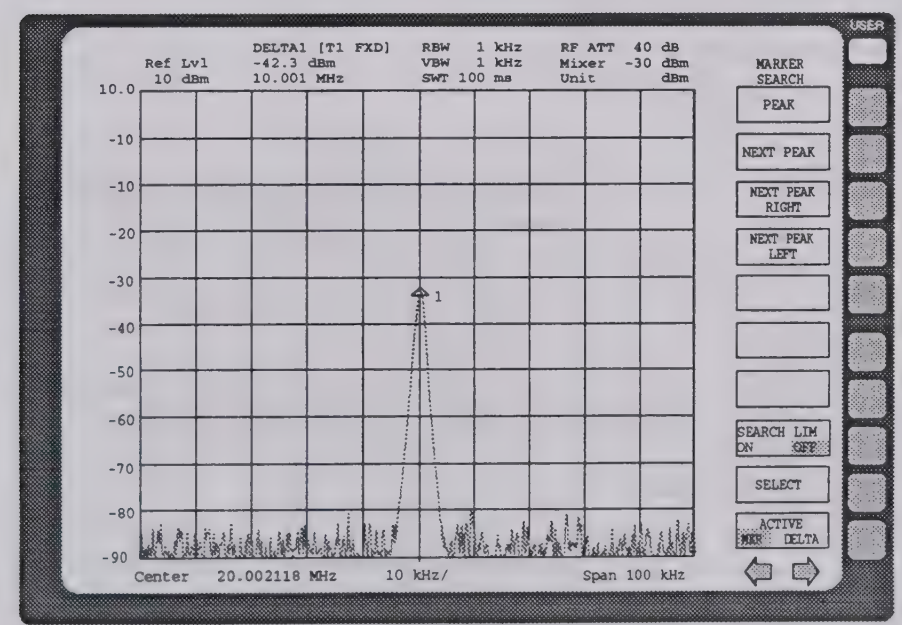


Figure 2.1-8 Measurement of the first harmonic

Note: *The spurious harmonics generated internal to the analyzer can be easily recognised by switching in additional RF attenuation. When an additional 10 dB attenuation is inserted, the displayed level of harmonics generated by the analyzer will be reduced by 10 dB, however, harmonics from the UUT will remain unchanged. This assumes that the receiver noise is substantially below the displayed level.*

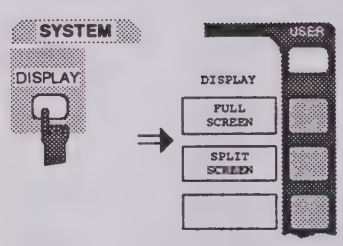
2.1.2.5 Measurement Procedure - Harmonic Separation – Example 3

The measurement of fundamental and harmonics can also be performed in two independent windows on the display screen (SPLIT-SCREEN mode). This mode permits the simultaneous presentation of the fundamental and harmonics with higher resolution and dynamic range.

The following measurement steps are carried out:

1. Reset the instrument.
2. Set the reference level to 10 dBm.
3. Connect the rear-panel 10 MHz reference signal (connector EXT REF IN/OUT) to the analyzer input RF INPUT.
4. Set the start frequency to 5 MHz.
5. Set the stop frequency to 55 MHz.
6. Smooth the displayed noise with the video bandwidth.
7. Measure the fundamental signal with the marker.
8. Reduce the measurement frequency range (ZOOM function):
9. Set the frequency step size to the fundamental frequency.
10. Set the display to two measurement windows.
11. Uncouple the window settings.
12. Measure the harmonic separation.

Set the analyzer according to Example 2 up to and including " Set the frequency step size to the fundamental frequency" (steps 1 to 9).



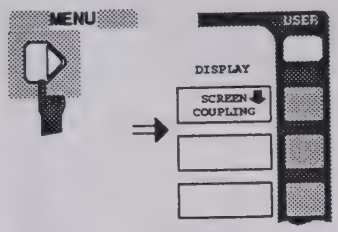
10. Set the display to two uncoupled measurement windows.

➢ Press the *DISPLAY* key in the *SYSTEM* key field.

The *SYSTEM DISPLAY* menu is opened.

➢ Press the *SPLIT SCREEN* soft key.

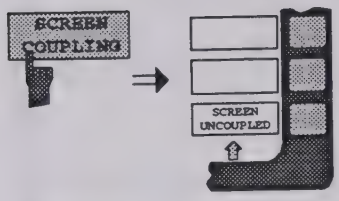
Two windows are displayed simultaneously on the display screen (see Fig. 2.1-9). The upper measurement window is called Screen A and the lower is called Screen B. At the initial turn-on, both measurement windows are coupled, i.e., changes in settings such as frequency or levels take place in both windows.



11. Uncouple the window settings

➢ Press the menu change key ▷.

The supplementary menu is opened.



➢ Press the *SCREEN COUPLING* soft key.

The *SCREEN COUPLING* sub-menu is opened.

➢ Press the *SCREEN UNCOUPLED* soft key .

The settings for each measurement window can now be selected independently. The entry is assigned to either *ACTIVE SCREEN A* or *ACTIVE SCREEN B* as selected by the soft key in the main menu window.

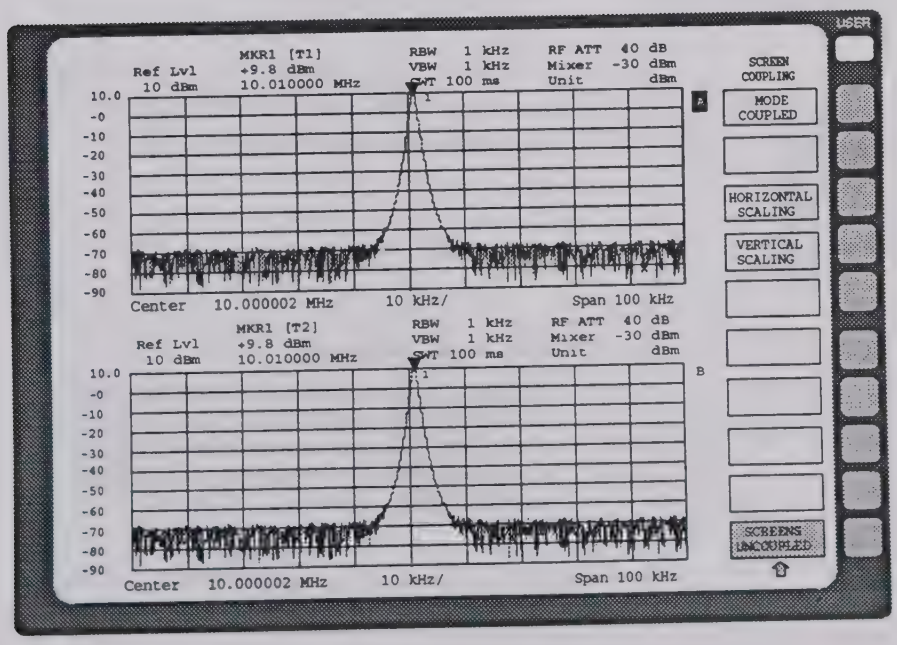
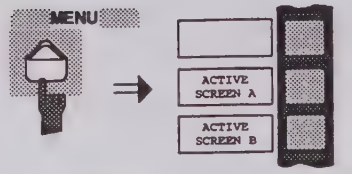


Figure 2.1-9 SPLIT-SCREEN mode



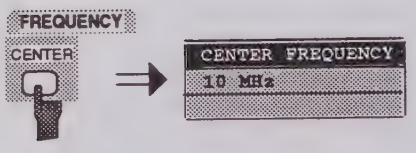
12. Measure the harmonic in the lower measurement window SCREEN B.

➢ Press the menu change key ⌓.

The main menu is opened.

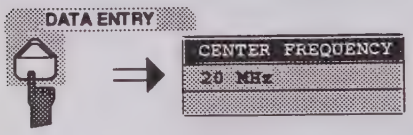
➢ Press the *ACTIVE SCREEN B* soft key.

The following entries are now valid for the lower window which is used to measure the harmonic separation.



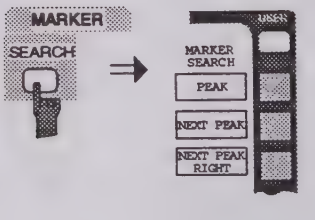
➢ Press the *CENTER* key in the *FREQUENCY* key field.

The entry field for the center frequency appears on the display screen.



➢ Press the cursor key ⌓ in the *DATA ENTRY* key field.

The center frequency is increased by one step. (= fundamental frequency).



➢ Press the *SEARCH* key in the *MARKER* key field.

The *SEARCH-MARKER* menu is opened.

➢ Press the *PEAK* soft key.

The delta marker appears at the first harmonic and measures the separation from harmonic to fundamental. The measured value is displayed in the marker field at the upper left of the display screen (see Fig. 2.1-10).

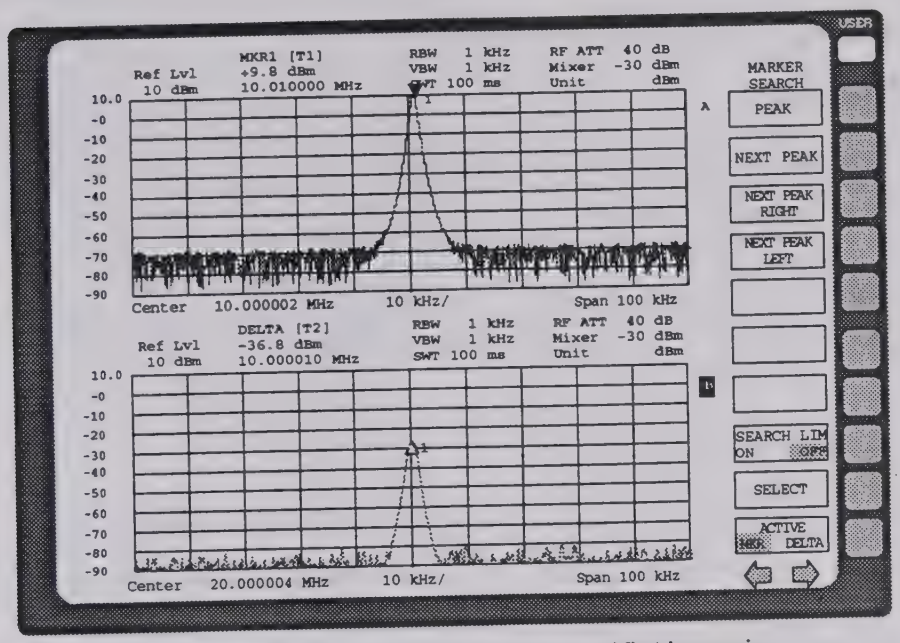


Figure 2.1-10 Alternate representation of fundamental and first harmonic

2.1.3 Measurement of Intermodulation Distortions

2.1.3.1 Measuring Task

If several signals are applied to a transmission quadripole with a non-linear characteristic, intermodulation products occur at its output due to addition and subtraction of the signals. The non-linear characteristic causes harmonics of the information signals to occur, which are mixed up at the characteristic. The low-order mixture products are particularly significant since they have the highest levels and are close to the information signals. The third-order intermodulation product causes the most significant distortions. In case of two-tone modulation it is the mixture product of the first information signal and the first harmonic of the second information signal.
The frequencies of the spurious signals occur with an offset of the information signals above and below the information signals. Figure 2.1-11 shows the intermodulation products P_{S1} and P_{S2}, which are obtained from the two information signals P_{N1} and P_{N2}.

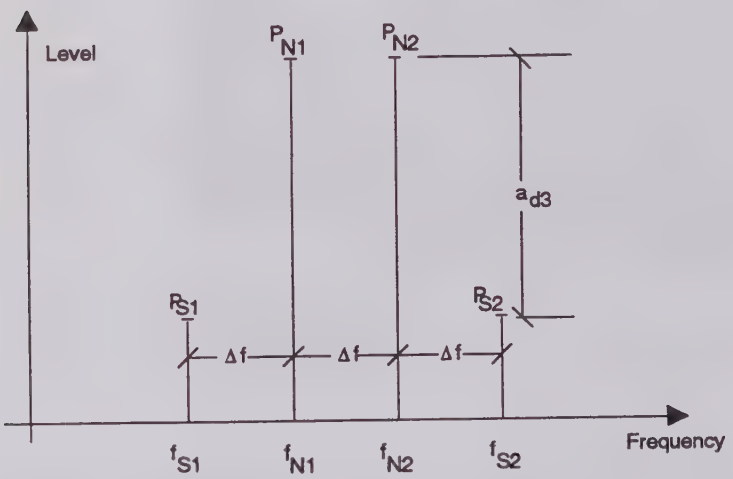


Fig. 2.1-11 Intermodulation products P_{S1} and P_{S2}

The intermodulation product at f_{S2} is obtained by mixture of the first harmonic of the information signal P_{N2} with the signal P_{N1}, the intermodulation product at f_{S1} by mixture of the first harmonic of the information signal P_{N1} with the signal P_{N2} .

$f_{s1} = 2 \times f_{n1} - f_{n2}$ (1)

$f_{s2} = 2 \times f_{n2} - f_{n1}$ (2)

The level of the spurious products depends on the level of the information signals. If both information signals are increased by 1 dB, the level of the spurious responses increases by 3 dB. I.e., the offset a_{d3} of the spurious responses decreases by 2 dB. This is illustrated by fig. 2.1-12.

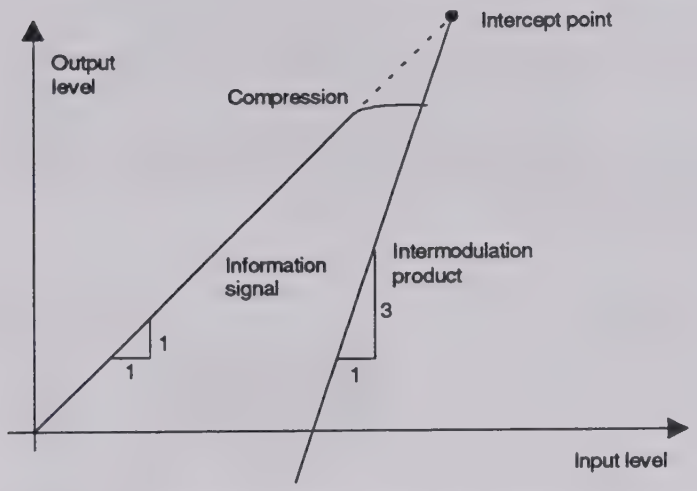


Fig. 2.1-12 Dependance of the spurious product level from the level of the information signals

The information signals at the output of a four-terminal network increase as the input level increases as long as the input level is in the linear range. If the level changes by 1 dB at the input, it also changes by 1 dB at the output. At a specified input level the quadripole compresses and the output level does not increase any more. The third-order intermodulation products increase three times as fast as the information signals. The intercept point is the fictitious level where both lines intersect. It cannot be measured directly since the wanted level is limited by the maximum output power of the quadripole.
It can however be calculated from the known gradients of the lines and the measured intermodulation offset a_{D3} with a given level using the following formula:

$$IP3 = \frac{a_{D3}}{2} + P_N \qquad (3)$$

If, e.g., the intermodulation offset is 60 dB and the input level P_N is -20 dBm, the third-order intercept IP3 is calculated as follows:

$$IP3 = \frac{60}{2} + (-20dBm) = 10dBm. \qquad (4)$$

2.1.3.2 Important Spectrum-Analyzer Functions

Correct setting of the RF attenuation is particularly important for intermodulation measurements. In the FSE, the attenuation can be set automatically according to the reference level. There are three coupling methods:

- RF ATTEN AUTO
- ATTEN AUTO LOW DIST
- ATTEN AUTO LOW NOISE

The coupling mode ATTEN AUTO LOW DIST is recommended to be used for measurement of intermodulation distortions since the intrinsic spurious products are minimized.

2.1.3.3 Measurement

In the following, measurement of the third-order intercept of an amplifier is described, by way of example.

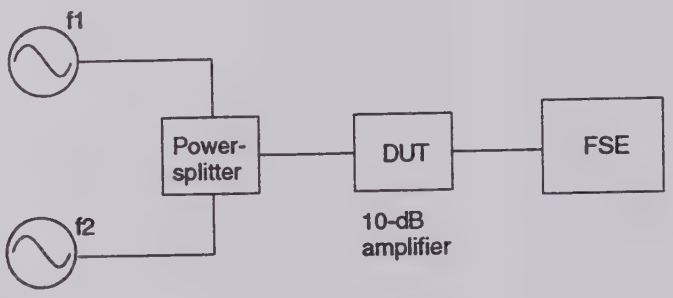
Two signal generators with the frequencies f_1 and f_2 supply signals to the amplifier via a power divider. The output of the device under test is connected to the RF input of the FSE. The level of the two signal generators is the same and is selected such that the DUT is not overloaded.

f_1 = 99.5 MHz

f_2 = 100.5 MHz

Level at amplifier input = -20 dBm with f_1 and $f_2$1

Test setup:



The following measurement steps are carried out:

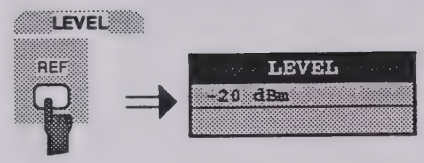
1. Reset the FSE.
2. Set the center frequency to 100 MHz.
3. Set the frequency-display range to 5 MHz (SPAN function).
4. Set the reference level to -10 dBm.
5. Set the resolution bandwidth to 10 kHz.
6. Set the RF attenuation for low-distortion mode.
7. Measure the intercept point using the markers.
8. Calculate IP3 from the measured offset and the signal level according to (4)

Cf. measurement example Level and Frequency Measurements (steps 1 to 3)

1. Reset the instrument.

2. Set the center frequency to 100 MHz.

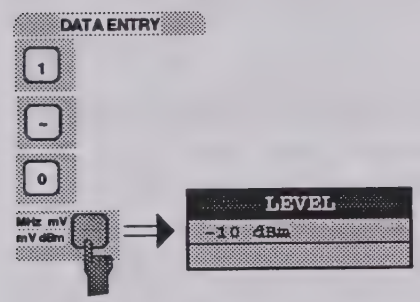
3. Set the frequency-display range to 5 MHz.



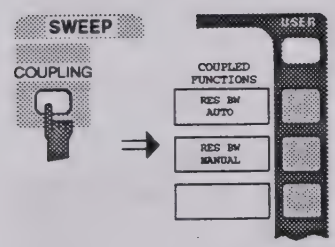
4. Set the reference level to -10 dBm

➢ Press the *REF* key in the *LEVEL* key field.

The entry window for the reference level is displayed.



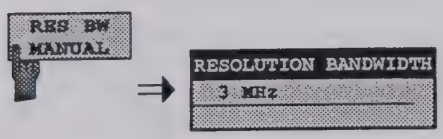
➢ Enter *-10* via the numeric keypad in the entry field and terminate the entry by pressing the *dBm* key.



5. Set the resolution bandwidth to 10 kHz

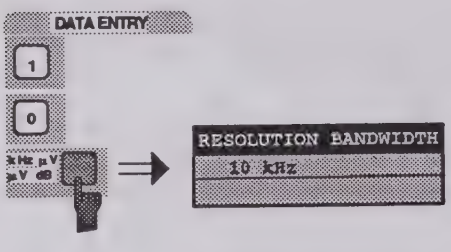
➢ Press the *COUPLING* key in the *SWEEP* key field.

The *SWEEP-COUPLING* menu is opened.

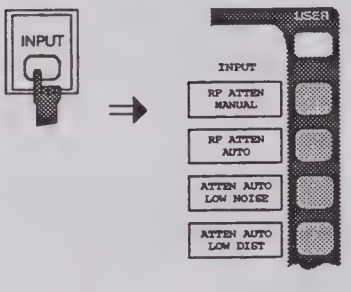


➢ Press the *RES BW MANUAL* softkey.

The entry field for the resolution bandwidth is displayed. .



➢ Enter *10* in the entry field via the numeric keypad and terminate the entry by pressing the *kHz* key.



6. Set low-distortion mode

➢ Press the *INPUT* key

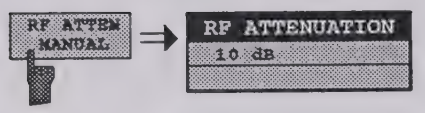
The *INPUT* menu is opened.

either

➢ Press the *ATTEN AUTO LOW DIST* softkey.

The low-distortion mode is selected. Thus, the combination of input attenuation and IF gain is selected such that the internal intermodulation products are the smallest possible and the intermodulation-free range is as large as possible.

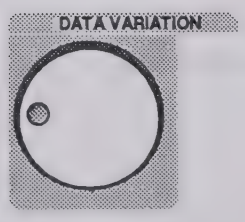
The FSE shows the measuring diagram in fig. 2.1-13



or

➢ Press the *RF ATTEN MANUAL softkey.*

The entry window for the RF attenuation is displayed .



➢ Vary the RF attenuation using the roll-key.

If the amplitude of the IM products doesn't change, the existing setting is sufficient
(see Fig. 2.1-13)

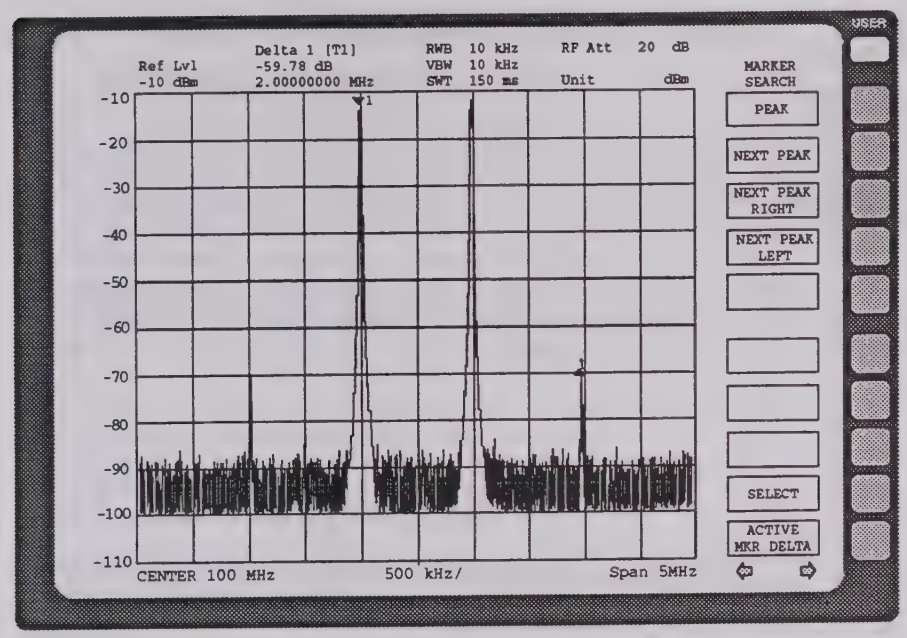


Fig. 2.1-13 Measuring diagram in low distortion mode

7. Measure the intercept point using the markers

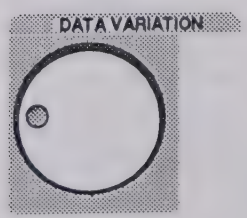
➢ Press the *NORMAL* key in the *MARKER* key field.

The marker appears on the fundamental (see also level and frequency measurement step 5, PEAK SEARCH function).

The measured values can be read off at the upper left of screen.

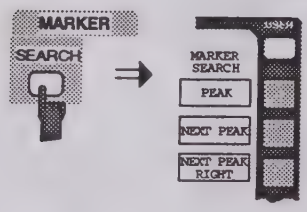
➢ Press the *DELTA* key in the *MARKER* key field.

The delta marker is active. It appears on the fundamental.



either

➢ Move the marker to an intermodulation product using the roll-key (see Fig. 2.1-13).



or

➢ Press the *SEARCH* key of the *MARKER* keys.

The *SEARCH-MARKER* menu is opened.

➢ Press the *NEXT PEAK RIGHT* softkey until the delta marker appears on one of the IM products (see fig. 2.1-13).

8. Calculate IP3 from the measured offset and the signal level according to (4)

In the example, an intermodulation ratio of approx. 60 dB at a level of -10 dBm was measured. IP3 is thus:

$$IP3 = 60\ dB/2 + (-10dBm) = 20\ dBm$$

2.1.4 Time-domain Measurements with Pulsed Signals

2.1.4.1 Measuring Task

A lot of systems which handle pulsed signals do not only require measurement of the pulse width and the pulse repetition rate which can be derived from the spectrum but also assess the rise and fall time as well as the power ramping during the pulse. In particular, modern digital mobile radio systems which, like GSM e.g., employ the TDMA method, require the power to be measured versus time over a wide dynamic range.

Time-domain measurements are performed using the spectrum analyzer with ZERO SPAN selected. The analyzer operates as fix-tuned receiver on the set center frequency such that the signal power versus time is displayed.

2.1.4.2 Important Spectrum Analyzer Functions

Trigger functions such as video trigger and sweep settings such as blanking of the measured value (GAP SWEEP) are of particular importance for time-domain measurements. The pretrigger function of the GAP SWEEP just enables measurement of rise times since it allows for representation of measurements prior to the trigger point. The GAP function, which enables cutout of a part of the pulse allows for simultanous representation of both edges of a pulse signal on the screen at high time resolution. During the GAP time, the sweep and thus data acquisition at the time marked by the "GAP" line is interrupted and thus the pulse is not completely displayed (the part which is not important for this measurement is blanked) (see fig. 2.1-14).

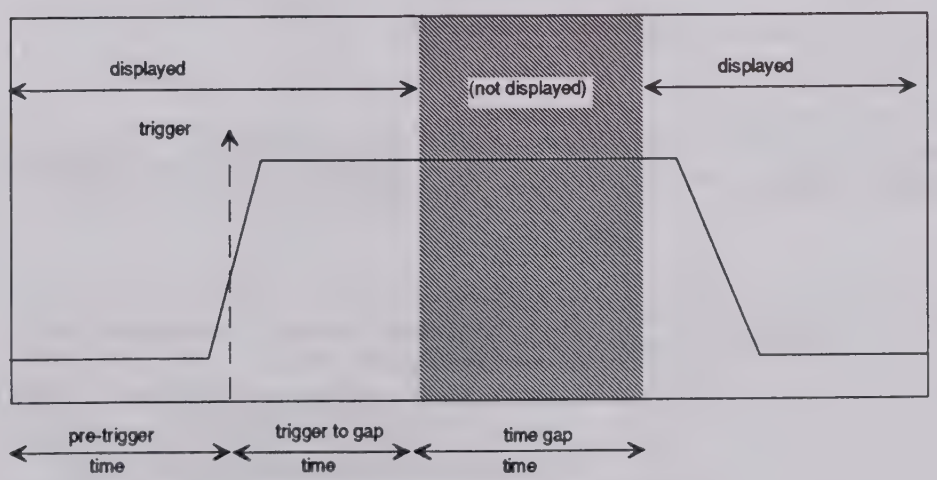


Fig. 2.1-14 Parameter beim Meßwertausblendung – Gap Sweep

Note: *If the pretrigger time and the trg-to-gap time is 0 s, the gap time function has the same effect as a delayed trigger.*

2.1.4.3 Measurement

This example shows the measurement of the rise and fall times as well as the power ramping during the pulse.

The signal generator SME with built-in pulse modulation source SME-B4 is used as signal source. A signal generator providing for pulse modulation in conjunction with an external pulse generator may be used, instead.
Settings on the signal generator:

Frequency	900 MHz
Level	–5 dBm
Modulation	Pulse
Pulse width	ca. 600 µs
Pulse frequency	ca. 500 Hz

The following measuring steps are made:

1. Reset the instrument.
   The video bandwidth is thus set to 3 MHz.
2. Set the center frequency to 900 MHz.
3. Set the frequency display range to zero span.
4. Set the reference level to 0 dBm.
5. Set the resolution bandwidth to 3 MHz.
6. Set the sweep time to 1 ms.
7. Connect the RF output of the SME to the RF input of the FSE.
8. Set the video trigger.
9. Set the sweep time to 100 µs.
10. Set the trigger points.
11. Activate the gap sweep.

---

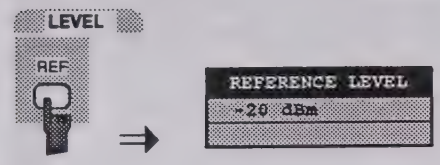
comp. measuring example - level and frequency measurement (steps 1 to 3)

1. Set the instrument to the default state. I.e., the video bandwidth is set to 3 MHz.

2. Set the center frequency to 900 MHz.

3. Set the frequency-display range to zero span.

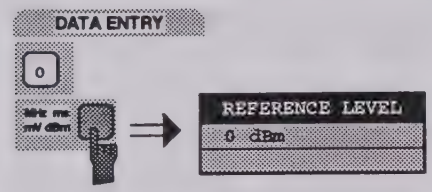
Note: *With first calling of the zero span following preset, a resolution bandwidth of 1 MHz is automatically set. Apart from that, switching on the zero span always causes that resolution bandwidth to be set that was last set in zero span.*



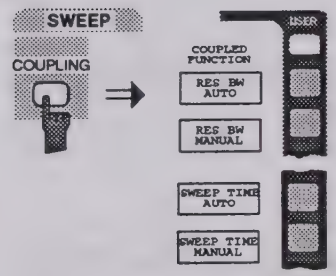
4. Set the reference level to 0 dBm.

➢ Press the *REF* key in the *LEVEL* key field.

The entry field for the reference level appears on the display screen.



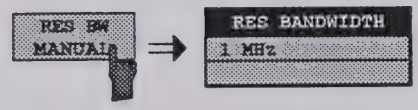
➢ Enter *0* in the entry field via the numeric keypad and terminate the entry by pressing the *MHz/ms* key.



5. Set the resolution bandwidth to 3 MHz

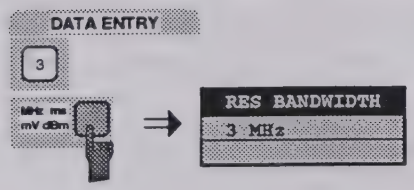
➢ Press the *COUPLING* key in the *SWEEP* key field.

The *SWEEP-COUPLING* menu is opened.

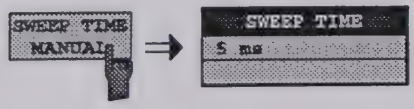


➢ Press the *RES BW MANUAL* soft key.

The entry field for the resolution bandwidth appears on the display screen.



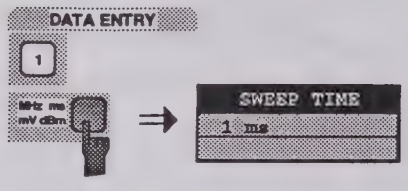
➢ Enter *3* via the numeric key pad and terminate the entry by pressing the *MHz* key.



6. Set the sweep time to 1 ms

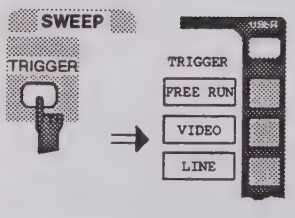
➢ Press the *SWEEP TIME MANUAL* softkey.

The entry field for the sweep time is opened.



➢ Enter *1* in the entry field via the numeric keypad and terminate the entry by pressing the *MHz* key.

7. Connect the RF output of the SME to the RF input of the FSE.



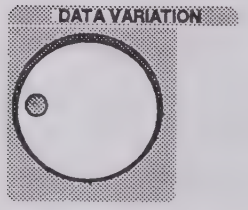
8. Initiate triggering by means of the display voltage (video trigger)

➢ Press the *TRIGGER* key in the *SWEEP* key field

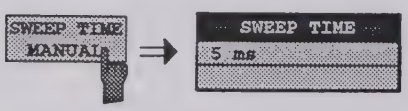
The *TRIGGER* menu is opened.

➢ Press the *VIDEO* softkey.

A dashed horizontal line is displayed which marks the trigger level.



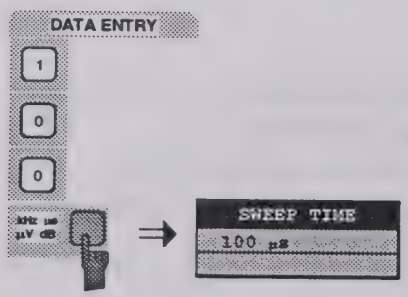
➢ Set the trigger level using the roll key such that a triggered display is obtained.
(see fig. 2.1-15)



9. Set the sweep time to 100 µs

➢ Press the *SWEEP TIME MANUAL* softkey.

The window for entering the sweep time is opened.



➢ Enter *100* via the numeric keypad and terminate the entry by pressing the *kHz/µs* key.

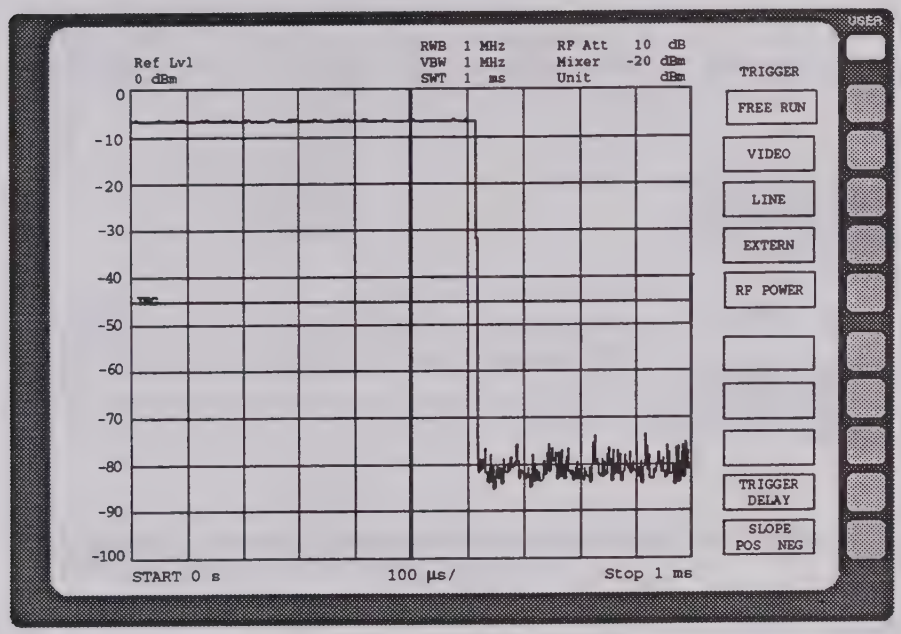
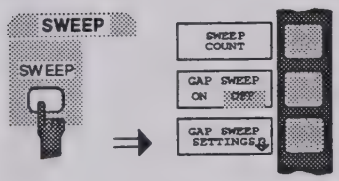


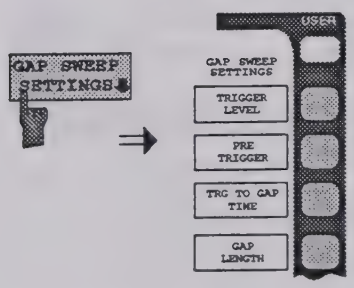
Fig. 2.1-15 Representation of pulse sequence with video trigger



10. Set the trigger points.

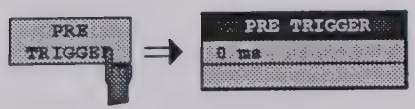
➢ Press the *SWEEP* key in the *SWEEP* keyfield.

The *SWEEP* menu is opened.



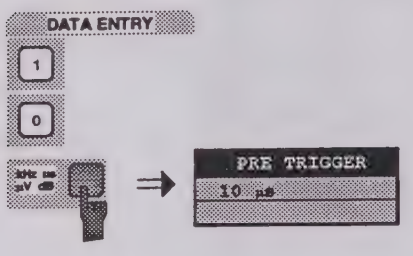
➢ Press the *GAP SWEEP SETTINGS* softkey.

The *GAP SWEEP SETTINGS* submenu for setting the trigger points is opened.

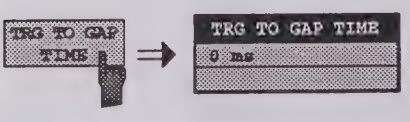


➢ Press the *PRE TRIGGER* softkey.

The entry field for the pretrigger is opened.

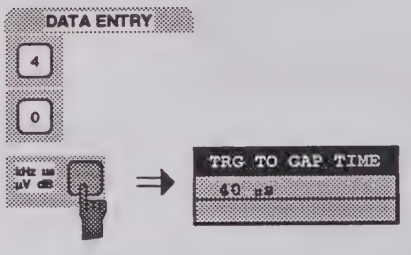


➢ Enter *10* via the numeric keypad in the entry field and terminate the entry by pressing the *kHz/µs* key.

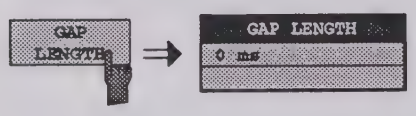


➢ Press the *TRG TO GAP TIME* softkey.

The entry field for the trigger-to-gap-time is opened.

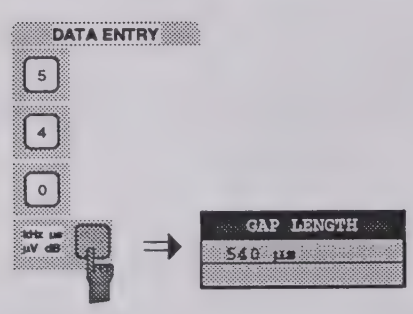


➢ Enter *40* via the numeric keypad in the entry field and terminate the entry by pressing the *kHz/µs* key.

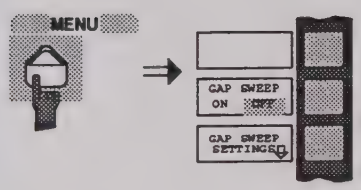


➢ Press the *GAP LENGTH* softkey.

The entry field for the length of the time gap is opened.



➢ Enter *540* in the entry field via the numeric keypad and terminate the entry by pressing the *kHz/µs* key.



11. Activate the measurement with mask-out of measured value

➢ Press the menu change key.

The right supplementary menu is opened.

➢ Press the *GAP SWEEP ON/OFF* key.

The measurement with blanking of measured value is activated. The measurement results are shown in figure 2.1-16

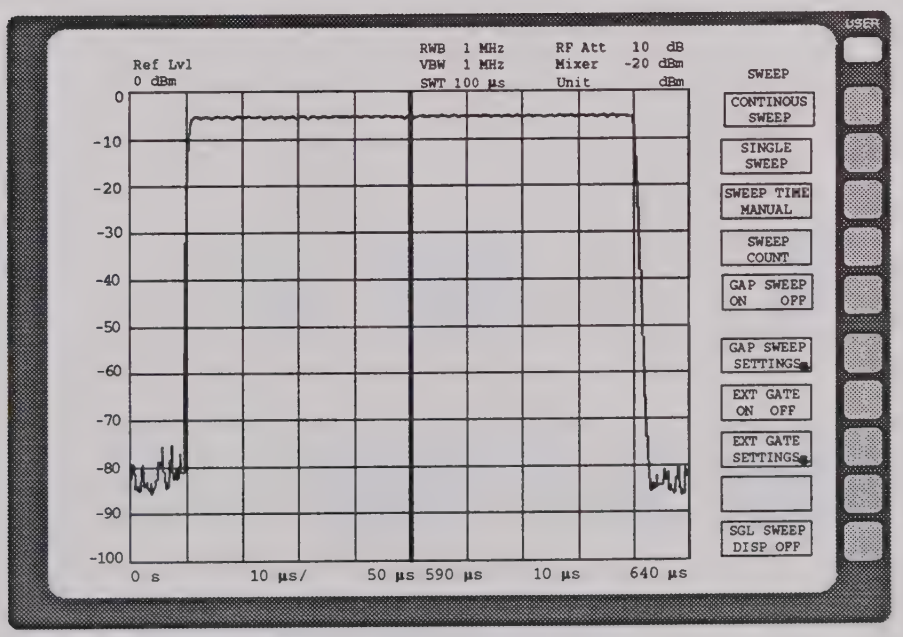


Fig. 2.1-16 Measured-value blanking for simultaneous display of rising and falling edge of a pulse signal. The position of the gap is indicated by the thick vertical line. The gap time is indicated via the double label 50 µs and 590 µs in the time axis.

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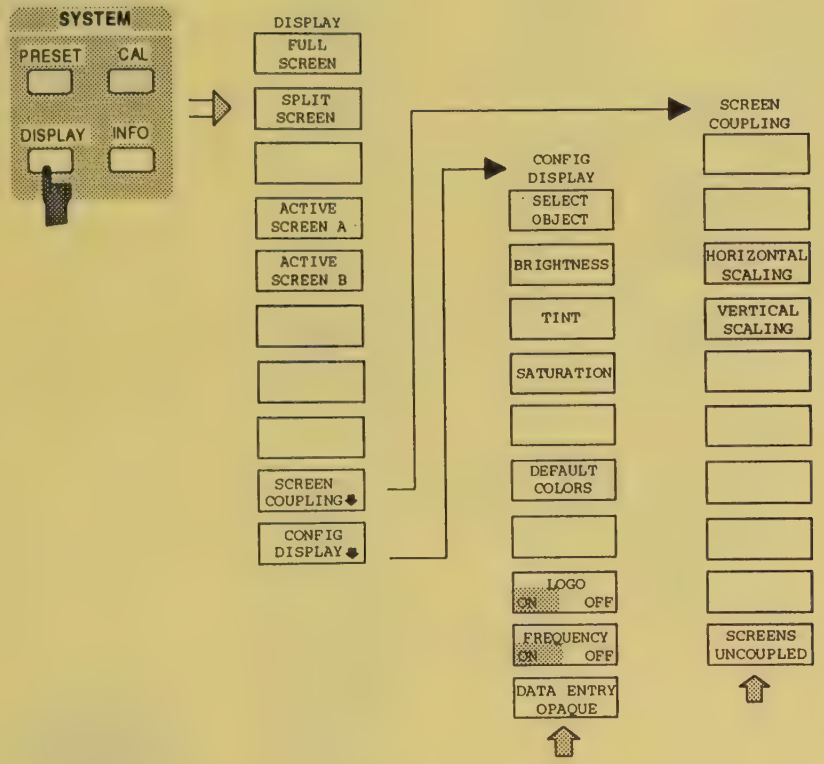
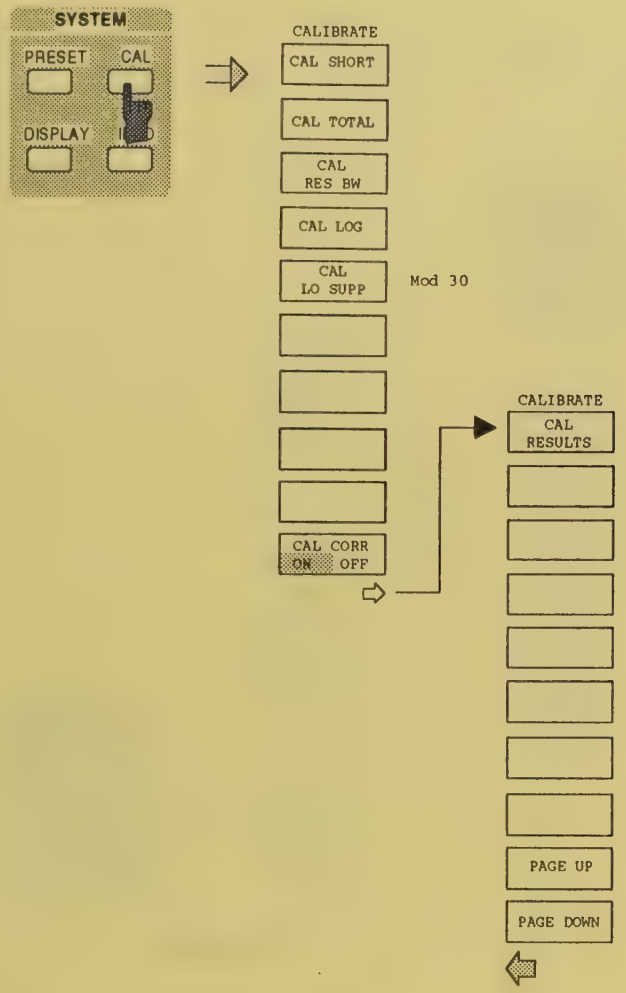
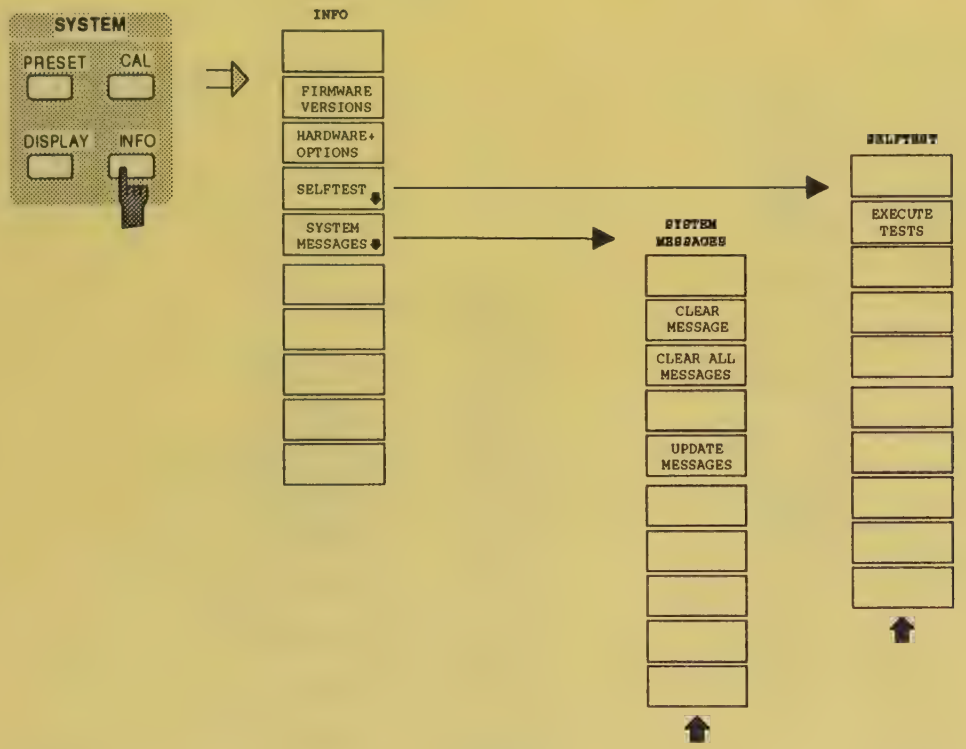
2.2 Menu Overview

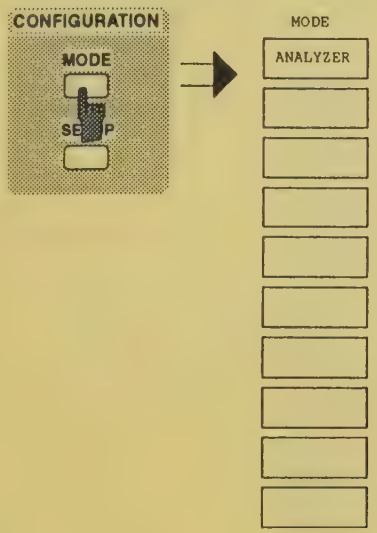
2.2.1 *SYSTEM* Key Group

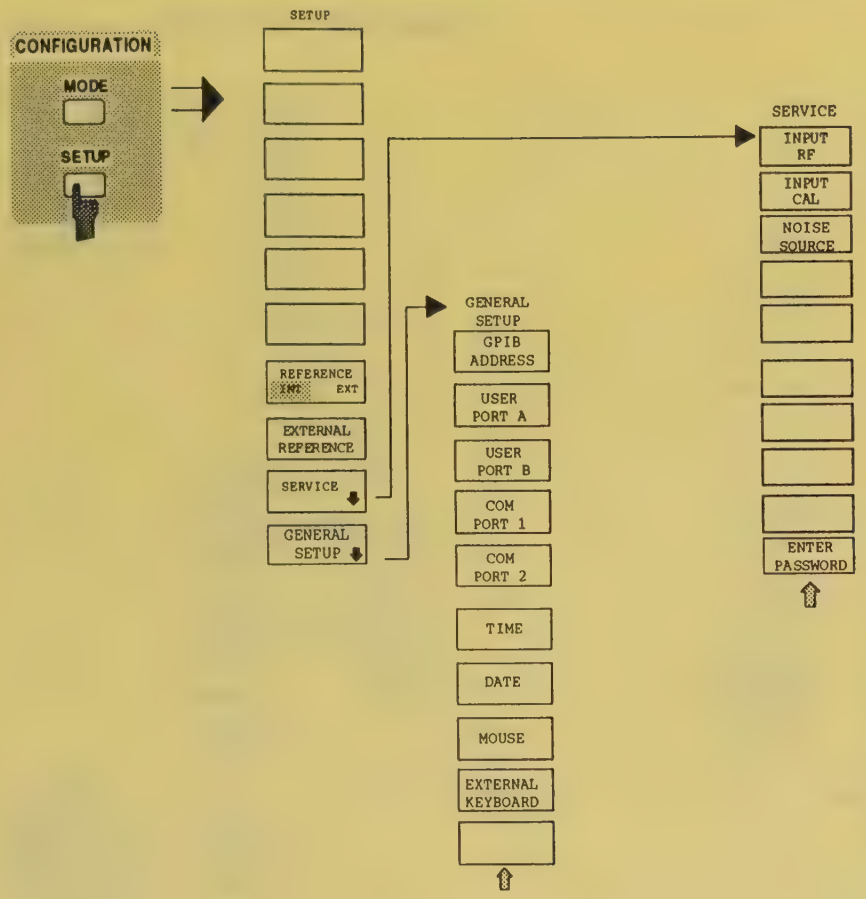



SYSTEM
PRESET
CAL
DISPLAY
CALIBRATE
CAL SHORT
CAL TOTAL
CAL RES BW
CAL LOG
CAL LO SUPP
Mod 30
CAL CORR ON OFF
CALIBRATE
CAL RESULTS
PAGE UP
PAGE DOWN

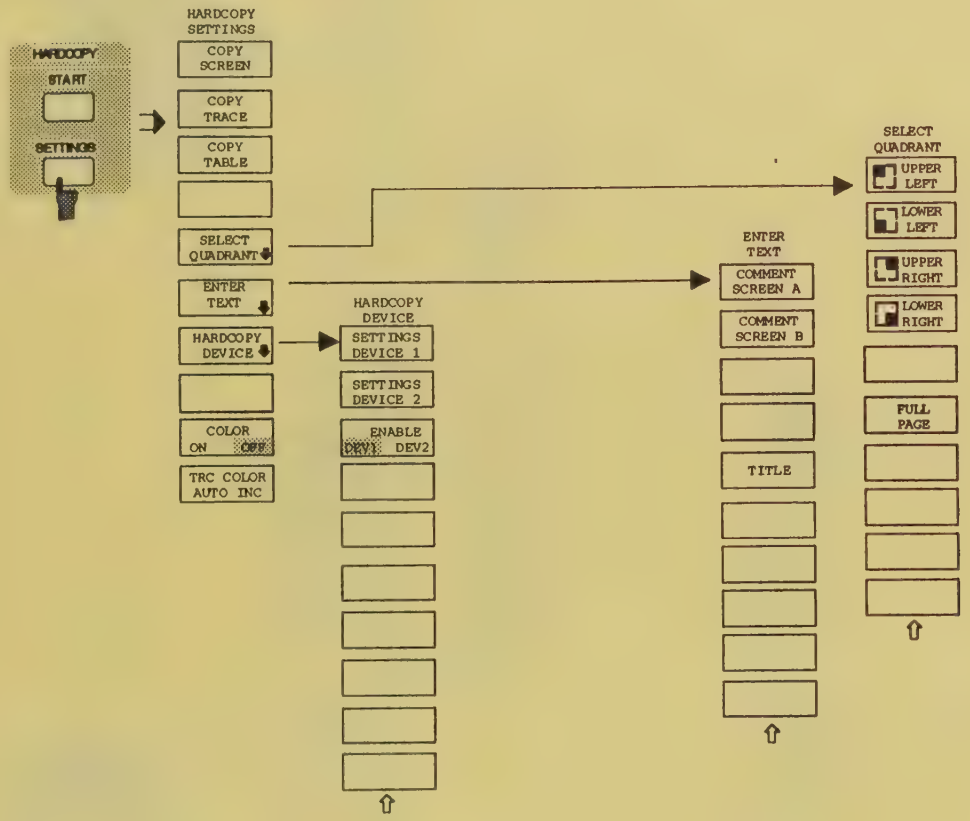

SYSTEM
PRESET
CAL
DISPLAY
INFO
INFO
FIRMWARE VERSIONS
HARDWARE+ OPTIONS
SELFTEST
SYSTEM MESSAGES
CLEAR MESSAGE
CLEAR ALL MESSAGES
UPDATE MESSAGES
EXECUTE TESTS

2.2.2 *CONFIGURATION* Key Group



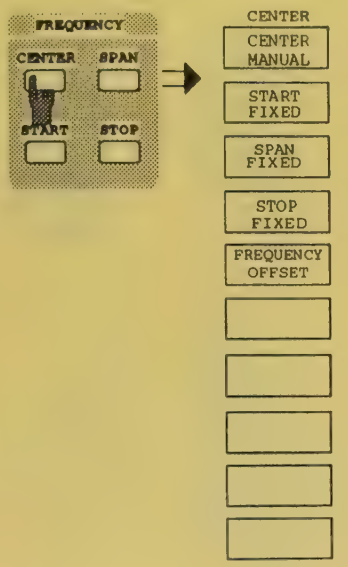

CONFIGURATION
MODE
SETUP
SETUP
REFERENCE
INT EXT
EXTERNAL
REFERENCE
SERVICE
GENERAL
SETUP
GENERAL
SETUP
GPIB
ADDRESS
USER
PORT A
USER
PORT B
COM
PORT 1
COM
PORT 2
TIME
DATE
MOUSE
EXTERNAL
KEYBOARD
SERVICE
INPUT
RF
INPUT
CAL
NOISE
SOURCE
ENTER
PASSWORD

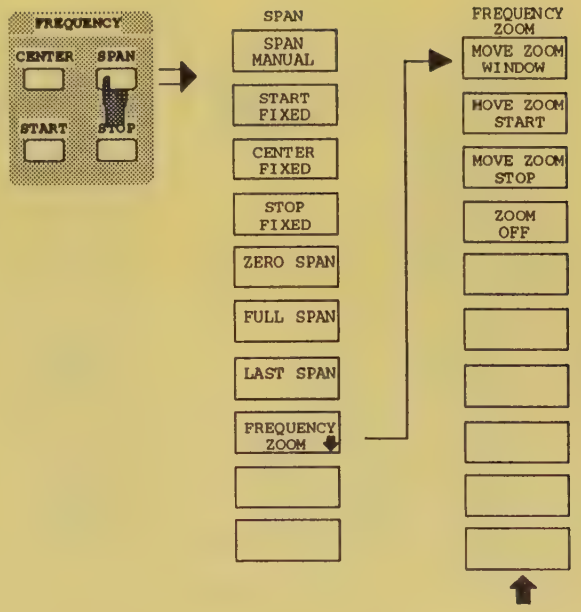
2.2.3 *HARDCOPY* Key Group

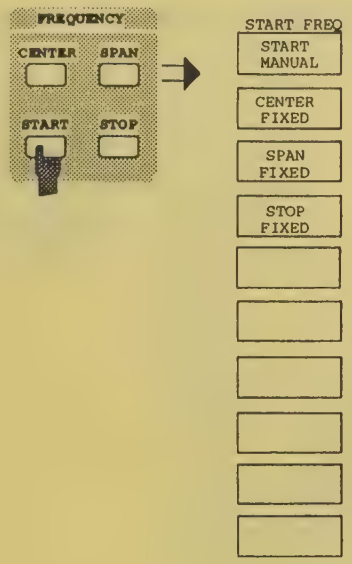


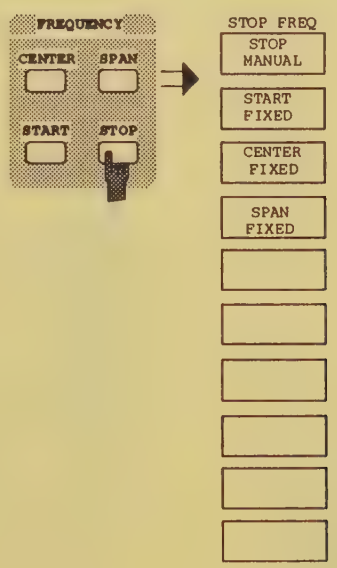
no softkey menu

2.2.4 *FREQUENCY* Key Group

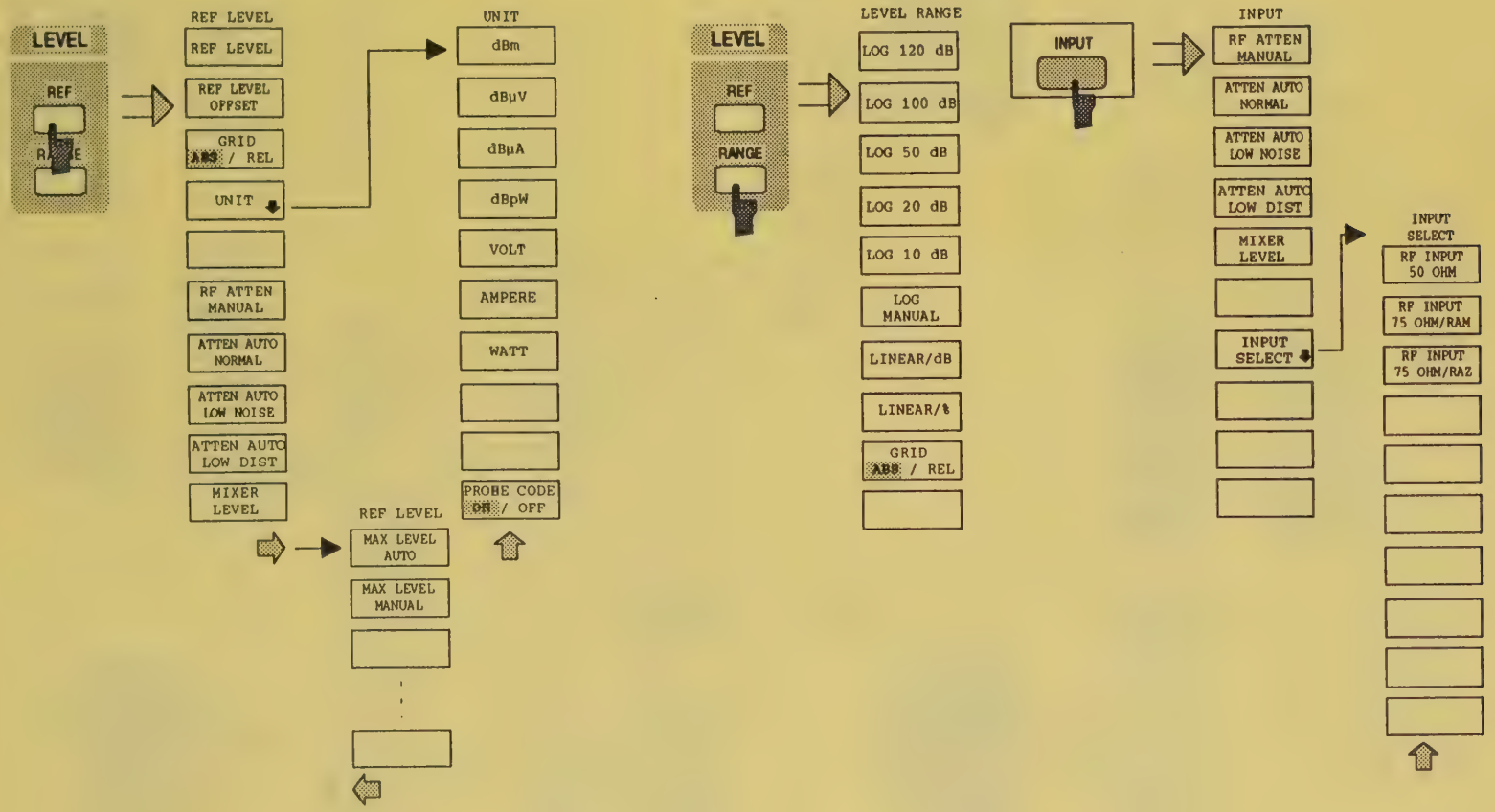




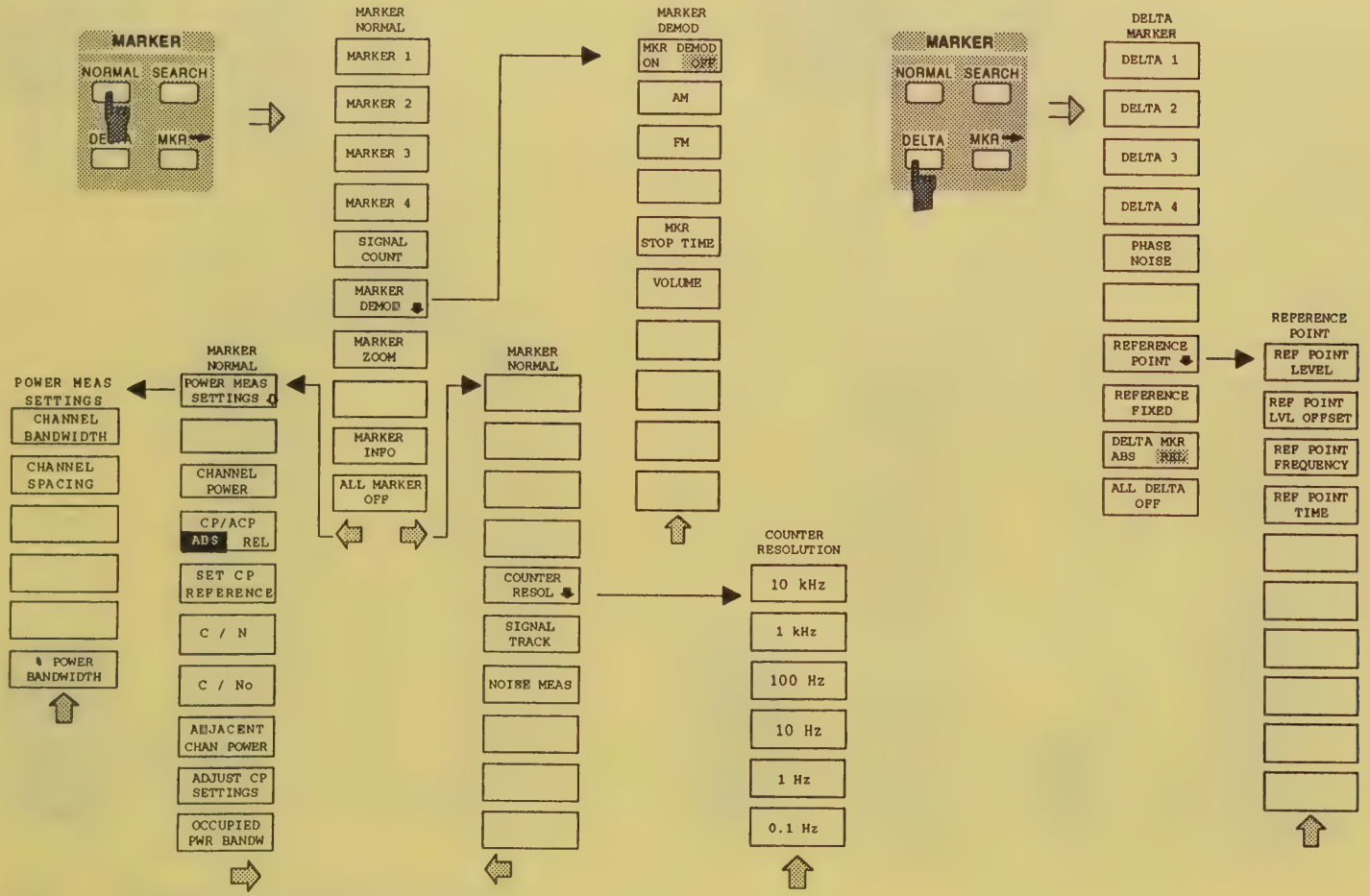

FREQUENCY
CENTER
SPAN
START
STOP
START FREQ
START MANUAL
CENTER FIXED
SPAN FIXED
STOP FIXED

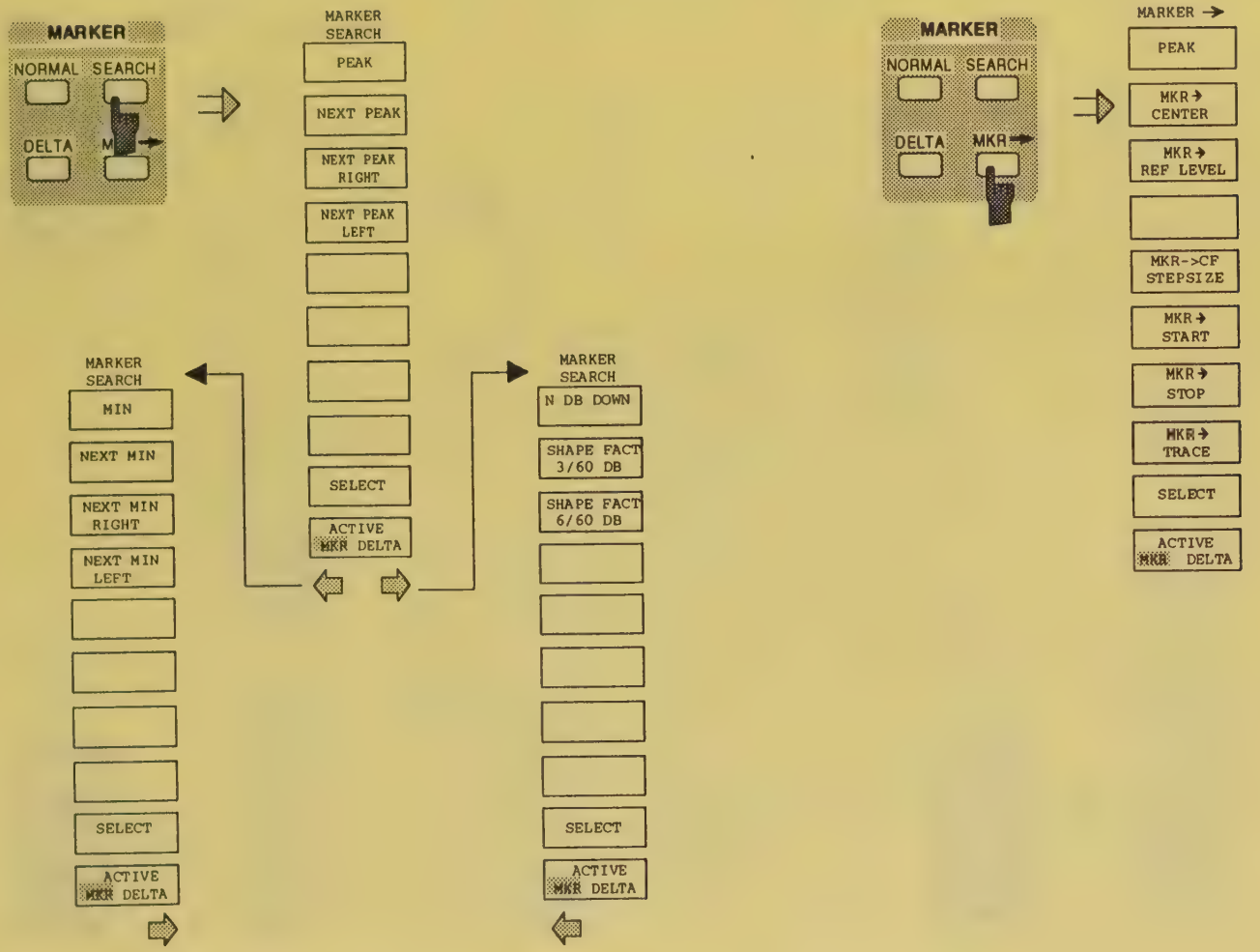

FREQUENCY
CENTER
SPAN
START
STOP
STOP FREQ
STOP MANUAL
START FIXED
CENTER FIXED
SPAN FIXED

2.2.5 *LEVEL* Key Group, *INPUT* Key

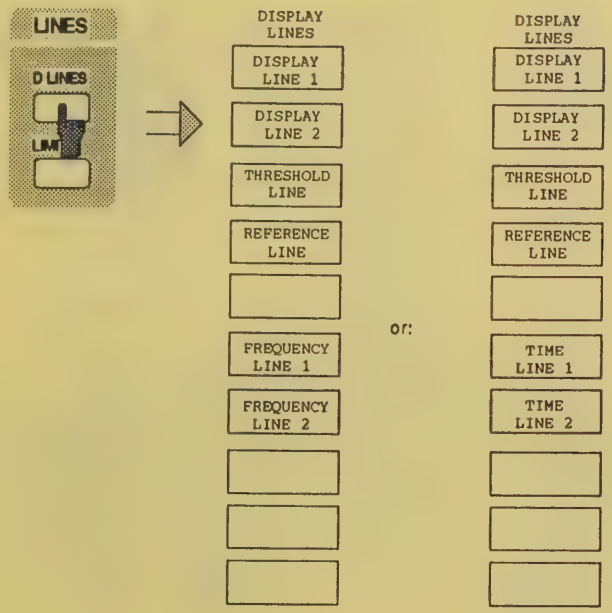


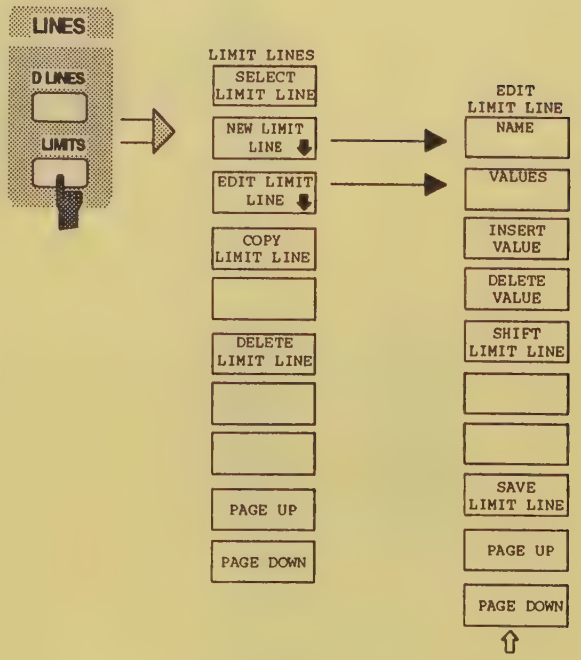
2.2.6 *MARKER* Key Group



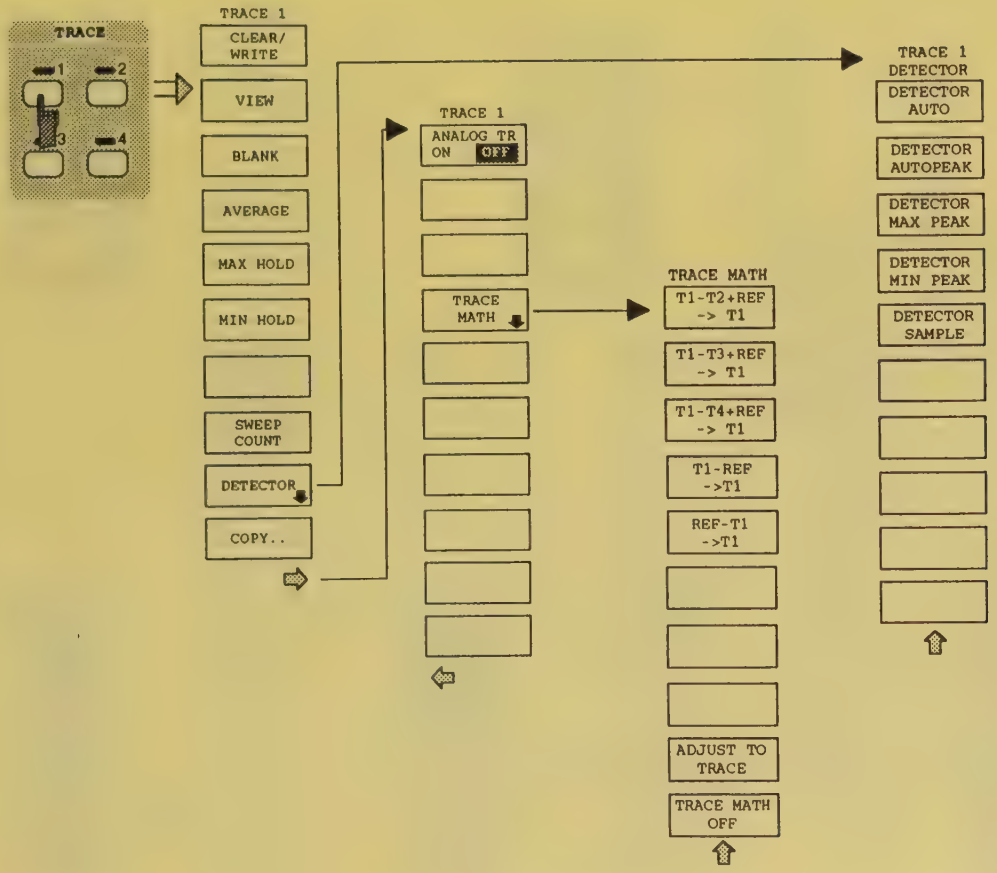

MARKER
NORMAL
SEARCH
DELTA
MKR
MARKER SEARCH
PEAK
NEXT PEAK
NEXT PEAK RIGHT
NEXT PEAK LEFT
SELECT
ACTIVE MKR DELTA
MARKER SEARCH
MIN
NEXT MIN
NEXT MIN RIGHT
NEXT MIN LEFT
SELECT
ACTIVE MKR DELTA
MARKER SEARCH
N DB DOWN
SHAPE FACT 3/60 DB
SHAPE FACT 6/60 DB
SELECT
ACTIVE MKR DELTA
MARKER
NORMAL
SEARCH
DELTA
MKR
MARKER →
PEAK
MKR→ CENTER
MKR→ REF LEVEL
MKR->CF STEPSIZE
MKR→ START
MKR→ STOP
MKR→ TRACE
SELECT
ACTIVE MKR DELTA

2.2.7 *LINES* Key Group

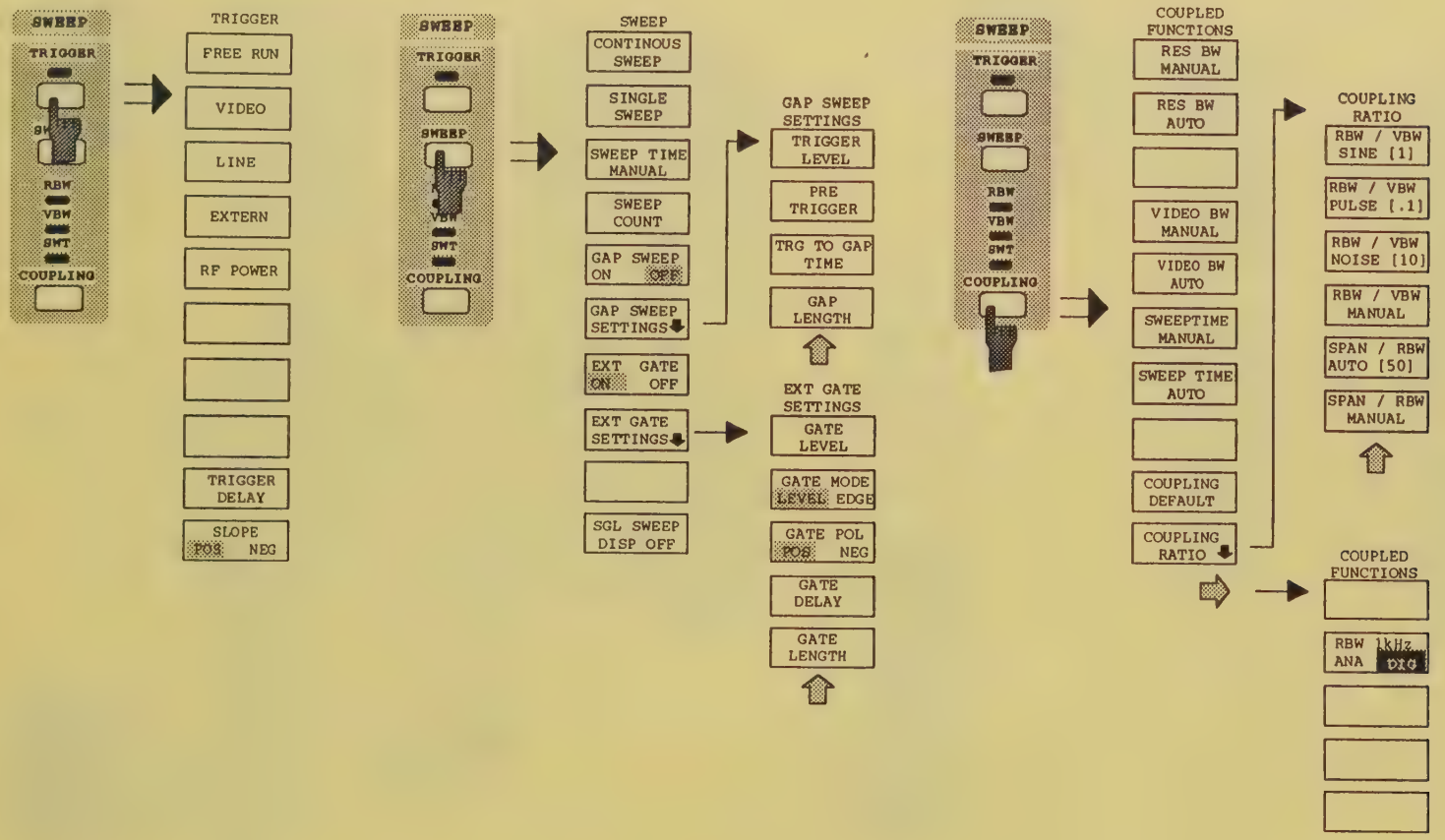




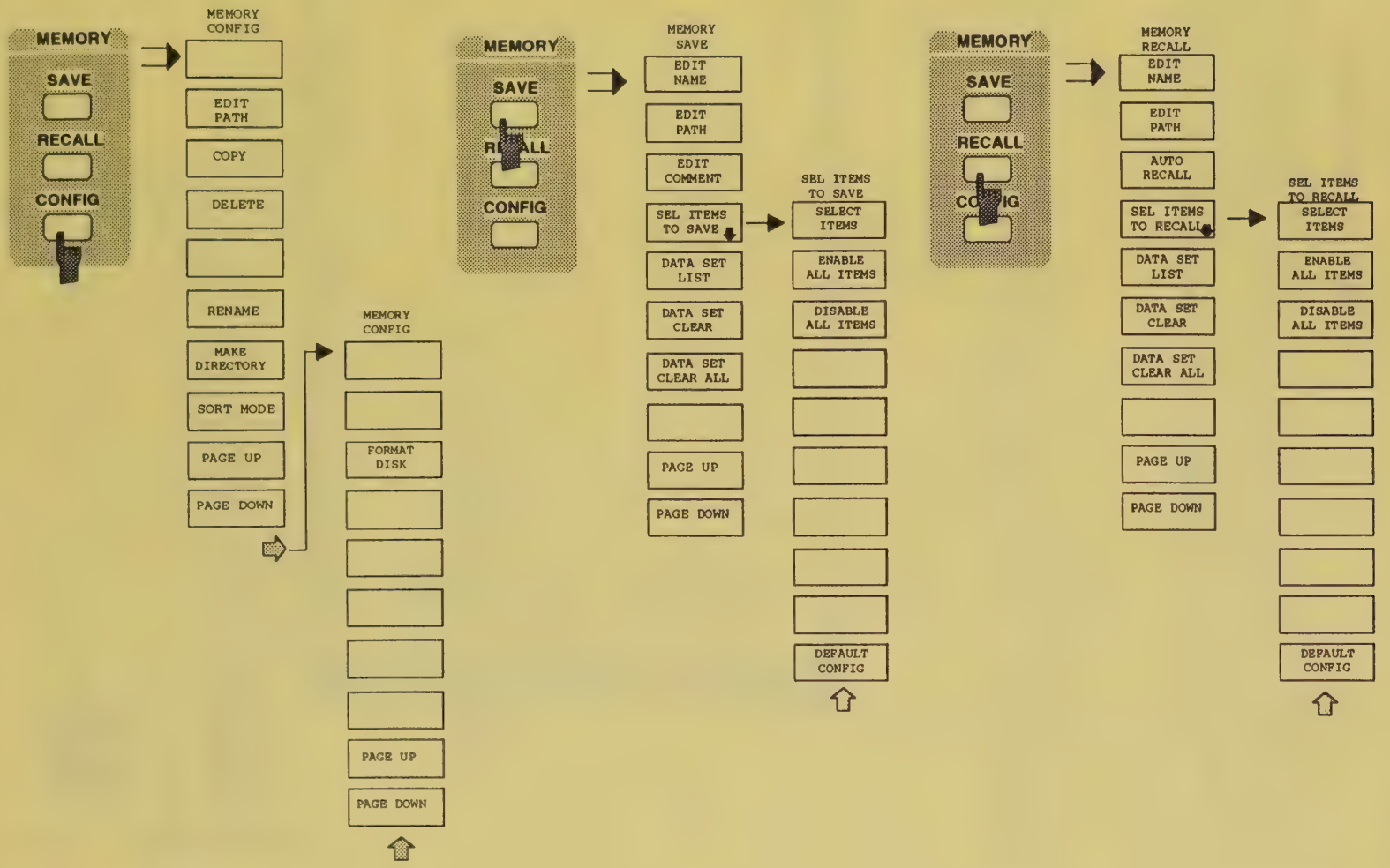
2.2.8 *TRACE* Key Group



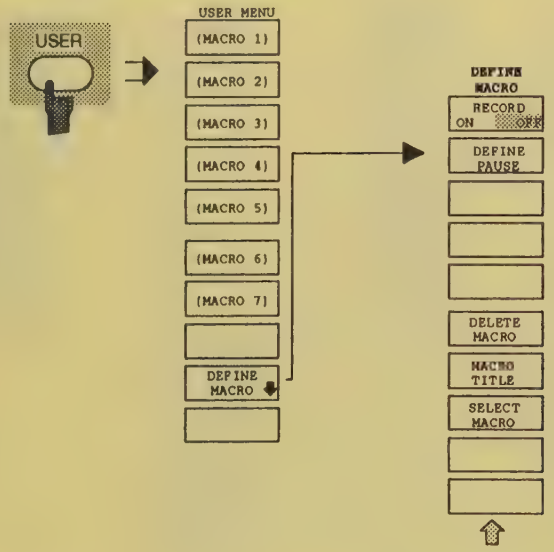
2.2.9 *SWEEP* Key Group



2.2.10 *MEMORY* Key Group



2.2.11 *USER* Key Group



2.3 Basic Steps of Operation

After switching on the instrument a message about the BIOS version installed is displayed for a few seconds. The instrument variant is displayed next. Subsequently, the instrument starts measuring. The type of measurement which was activated prior to last switch-off is performed, as long as no other instrument configuration was selected via *AUTO RECALL* in the *MEMORY RECALL* menu. While the measurement is being performed other menus and measuring modes can be entered simultaneously. The measurement results and the settings of the parameters are displayed on the screen.

2.3.1 The Screen

The screen informs continuously on the results and parameters of the selected measuring functions. It shows the assignment of the softkeys and menus, which are required for setting the measuring parameters. The display of test results, the softkey labelling and the type of menu depend on the selected measuring function.

The screen is subdivided into two areas:

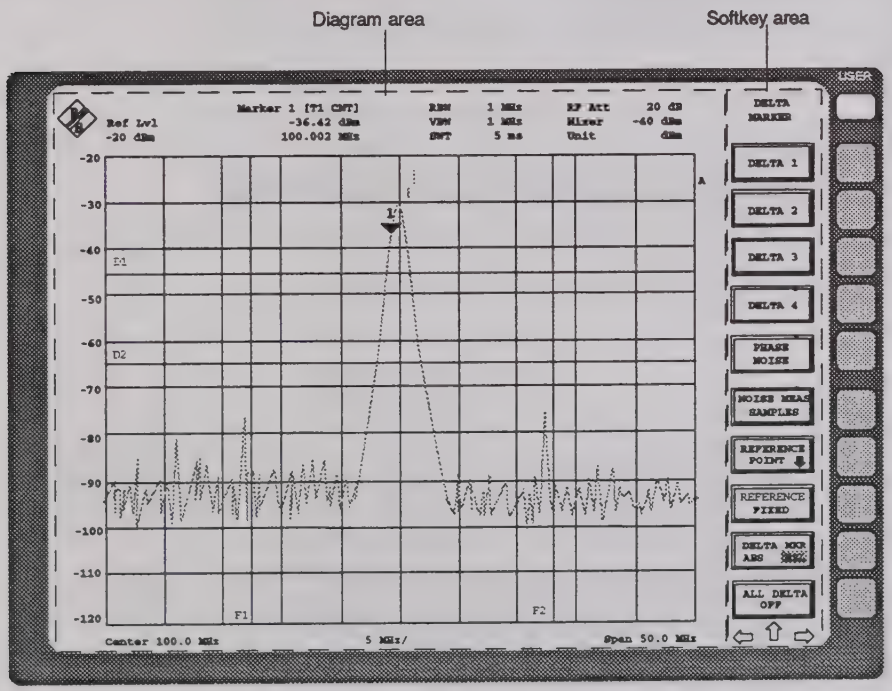


Fig. 2.3-1 Subdivision of screen

Diagram area This area contains the measuring diagrams and other measured-value information as well as the parameters and status information which are important for analysis of the results.
In addition, message fields, entry windows and tables may be shown in this area.

Softkey area This area contains the instrument functions which can be selected via the softkeys. The softkey area is not superimposed by other graphics.

2.3.1.1 Diagram Area

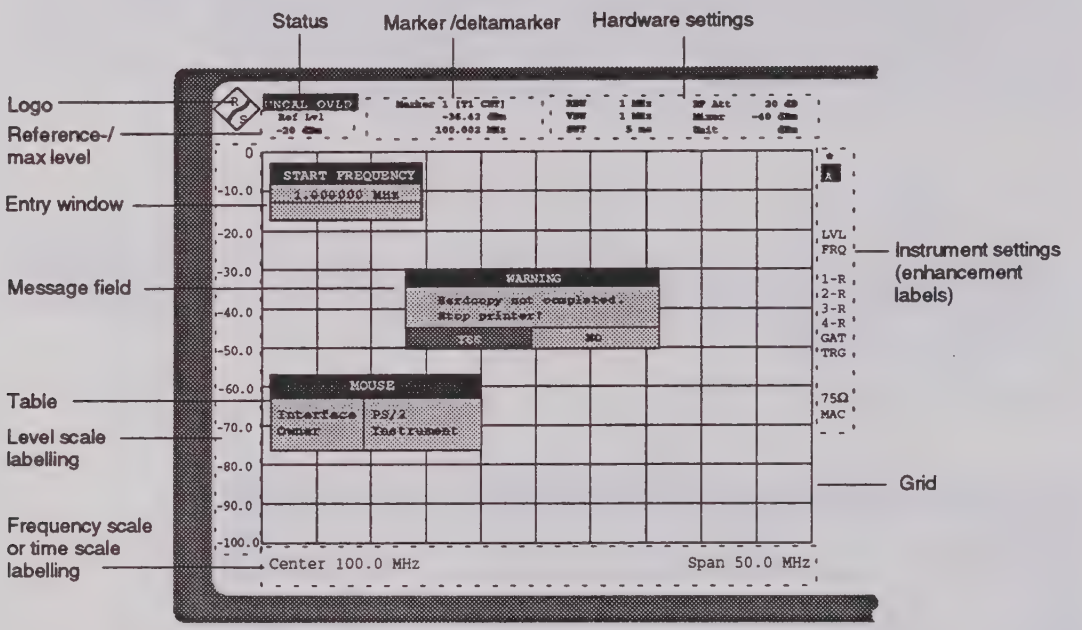


Fig. 2.3-2 Subdivision of the FSE screen in analyzer mode (without measuring diagram)

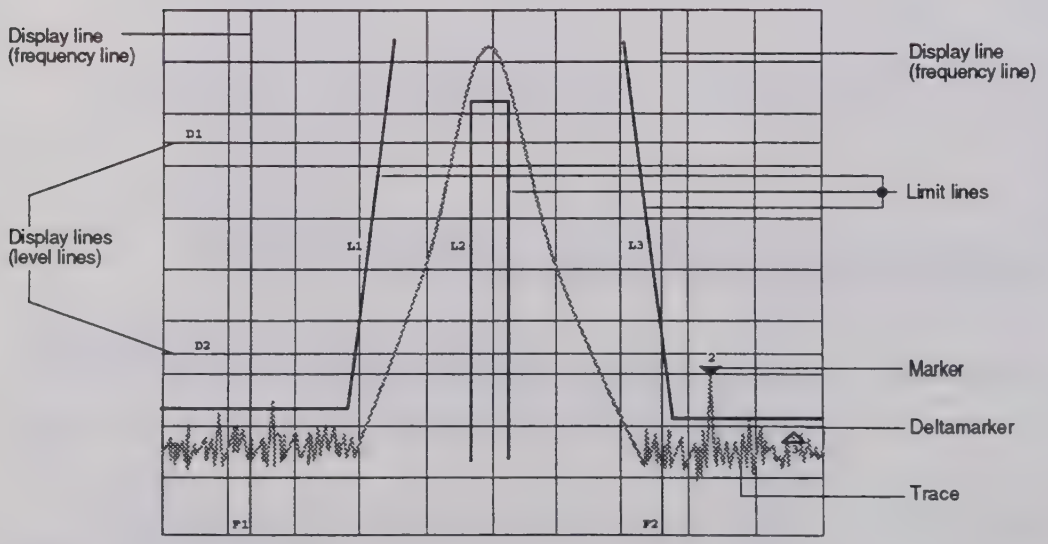


Fig. 2.3-3 Measuring diagram

The following graphic elements are displayed in the diagram area:

Status information

Hint at irregularity (e.g. UNCAL)
In addition the status display displays MAX / REF LVL, if the maximum level and the reference level have different values.

Marker/Deltamarker

This label displays the position of the last selected marker or deltamarker in the x and y-directions and the marker/deltamarker index. As additional information, 2 fields in square brackets are provided which contain the curve which the marker is assigned to and the active measuring function of the marker indicated. The measuring function of the markers in the second field is indicated by the following abbreviations:

CNT frequency counter actived

NOI noise measurement active

Hardware settings

RBW Indication of the set resolution bandwidth.

VBW Indication of the set video bandwidth.

SWT Indication of the set sweep time.

RF Att Indication of the set RF attenuation.

Mixer Indication of the maximum level at the input mixer (= level of the reference level REF LVL).

Unit Indication of the level unit of the measuring results and the associated setting and test parameters in full length. This label is particularly important for selection of units with more than 4 digits, since they can only be indicated as dB* in the other labels (except for marker).

Grid

X-axis: frequency or time,
Y-axis: level

Instrument settings
(Enhancement Labels)

Indication of user instrument settings which influence the measuring result and which are not immediately obvious when viewing the measured values.

* The current instrument setting does not correspond to the one which applied when one of the displayed curves had been stored. This occurs under the following circumstances:

- The instrument setting is modified while a sweep is being performed.
- The instrument setting is modified in SINGLE SWEEP mode subsequent to the end of the sweep and no new sweep is started.
- The instrument setting is modified after setting the trace to VIEW.

The display is retained until the cause is eliminated by the user. I.e., either a new sweep is started (SINGLE SWEEP mode), or the trace of interest is switched to BLANK (all cases).

A Identification for screen A. Screen A is activated for the entry of test parameters.

(Enhancement Labels)

B	Identification for screen B. Screen B is activated for the entry of test parameters.
LVL	A level offset ≠ 0 dB has been set. A level offset of the installed tracking generator leads to the same display.
FRQ	A frequency offset ≠ 0 Hz has been set.
1-<n>	Subtraction Trace 1 - Trace <n> active (<n>: numeric value) or subtraction Trace 1 - Reference Line active (<n>: R)
2-<n>	Subtraction Trace 2 - Trace <n> active (<n>: numeric value) or subtraction Trace 1 - Reference Line active (<n>: R)
3-<n>	Subtraction Trace 3 - Trace <n> active (<n>: numeric value) or subtraction Trace 1 - Reference Line active (<n>: R)
4-<n>	Subtraction Trace 4 - Trace <n> active (<n>: numeric value) or subtraction Trace 1 - Reference Line active (<n>: R)
GAT	The frequency sweep is controlled via the *EXT TRIG/GATE* input of the instrument.
TRG	The instrument is not triggered in *FREE RUN* mode.
75 Ω	The input impedance of the unit is set to 75 Ω.
MAC	Macro recording active.

Frequency axis labelling Display of the x-scaling.

`123.4 ms/Div`

The distance between two grid lines is displayed in this label.

`Center 1.2345678901234 GHz`
`Start 1.2345678901234 GHz`

The set center frequency or start frequency is displayed in this label depending on whether the keys CENTER/SPAN or START/STOP were last pressed.
If span = 0 Hz, the center frequency is always displayed.

`Span 1.2345678901234 GHz`
`Stop 1.2345678901234 GHz`
`Trigger 1.234 ms`

The set frequency range (*SPAN*) or the stop frequency is displayed, depending on whether the keys CENTER/SPAN or START/STOP were last pressed.
If span = 0 Hz, the trigger moment (*PRETRIGGER*) is displayed.

Level axis labelling Display of the y-scaling.

Entry window The data entry window is superimposed in the diagram area, if required.

Reference level/ Max. level	Display of the set reference level or combined display of maximum level and reference level.
Limit lines	Limit lines are used to mark level curves or spectral distributions which must not be exceeded or dropped below.
Traces 1 to 4	Up to 4 traces can be displayed simultaneously.
Display lines	Utilities for trace analysis.

The FSE provides two display modes:

- Full Screen: 1 window, all traces are displayed in one window.
- Split Screen: 2 windows, traces, grid and labels are distributed on the two windows.

2.3.1.2 Split Screen

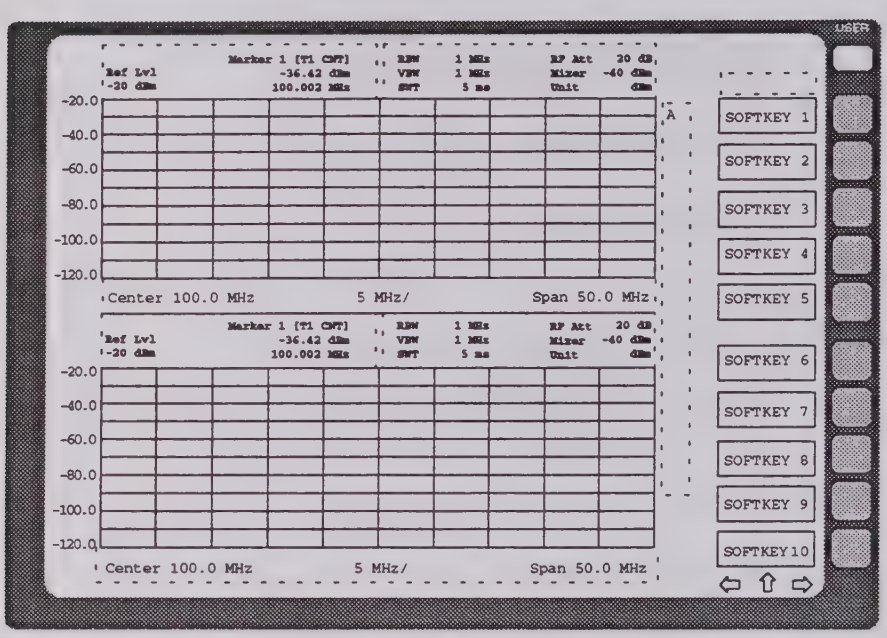


Fig. 2.3-4 Subdivision of the screen in Split Screen mode

In Split Screen mode, the screen is divided into two halves. The upper half is assigned Screen A, the lower one Screen B. The settings for measurement can be selected independently for both screens. E.g., a spectrum may be displayed in Screen A and a time amplitude in the time range is displayed in Screen B. The window for entry of the measuring parameters or the marker operation is selected using the *DISPLAY* key.

The assigment of traces to the windows is fixed and cannot be modified.

Table 2.3-1 Assignment of traces to windows with split screen

Trace 1:	upper (screen A)
Trace 2:	lower (screen B)
Trace 3:	upper (screen A)
Trace 4:	lower (screen B)

2.3.1.3 Softkey Area

The setup of the softkey area is independent of the operating mode. It consists of the following graphic elements:

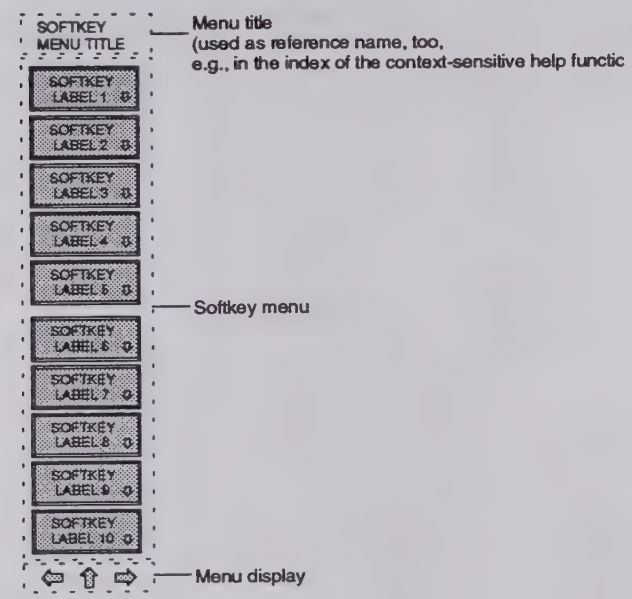


Fig. 2.3-5 Setup of the softkey area

The softkeys have different functions depending on the instrument state. Therefore, their labelling can be varied. The function and current state of the softkeys is indicated in the label by different texts and colors. The color assignment is factory-set as follows:

Table 2.3-2

Softkey color	Meaning
grey	Softkey switched off
green	Softkey switched on
red	Softkey switched on and data entry active

These colors can be changed by the user as desired.
A softkey is switched on or off by pressing the respective hardkey. If a mouse is connected to the instrument, the softkey label on the display can be selected using the mouse, alternatively.

If instrument functions depend on **options**, the associated softkeys may be completely masked out, if the options are not fitted. If instrument functions are not available temporarily due to different **operating modes,** the corresponding softkeys are disabled. Actuating the softkey has no function then. In this case, the softkey is represented "plane", i.e., without 3D effect.

2.3.2 Changing the Menu

With manual control, the FSE can be operated via the front-panel keys, the external keyboard or with a mouse.

Operation is menu-controlled. Various **softkey menus** are displayed depending on the instrument status. The individual menus constitute the so-called menu tree. The top menu (the root of the menu tree) is always called by means of a keystroke. The individual softkeys are then used to branch into further menus (submenus).

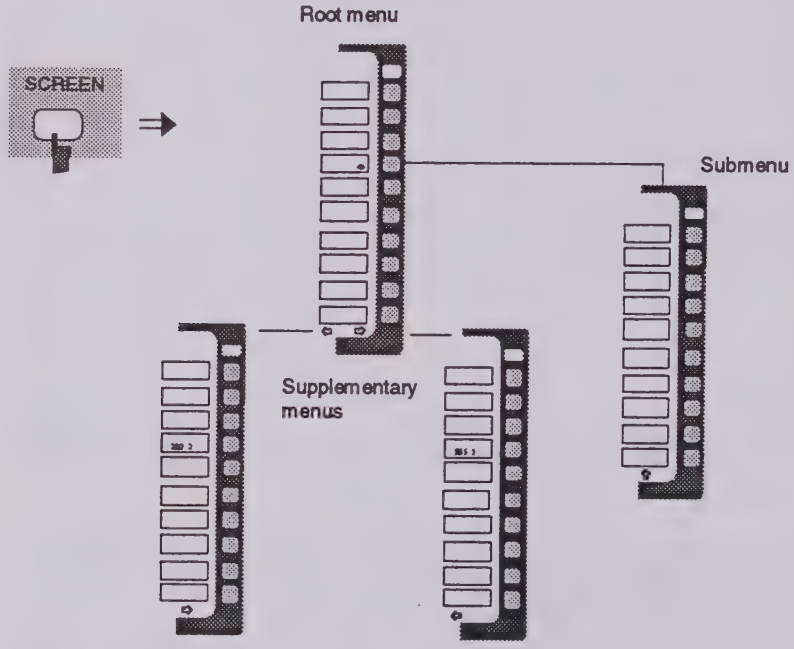


Fig. 2.3-6 Theory of menu selection

Each softkey menu consists of max. 30 softkeys, 10 softkeys being arranged in a main menu, 10 in a left-hand supplementary menu and 10 in a right-hand supplementary menu. In contrast to empty main menus, empty supplementary menus are not displayed. Arrows at the lower edge of the softkey area indicate whether a supplementary menu exists or not.

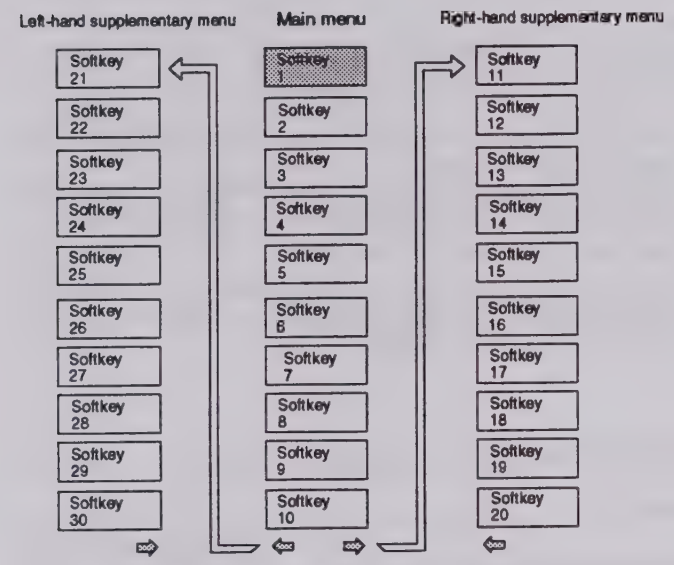


Fig. 2.3-7 Switching between main menu and supplementary menu

The menu arrows help to orient inside the menu tree.

Examples: ⇦ ⇨ This menu has a right-hand and a lefthand supplementary menu. It is the root menu since there is no ⇧ arrow.

⇧ ⇨ Only a right-hand supplementary menu or the upper menu can be accessed from this menu.

The MENU keys allow for selecting the main menu and the supplementary menus. If a mouse is connected to the instrument, the menu arrows can be selected to enter the respective menus. The MENU keys have the following functions:

When this key is pressed, the FSE enters the left-hand supplementary menu.

This key is pressed to call the upper menu which is located in the next higher hierarchical level in the menu tree. Several menus provide for automatic change, i.e., return to the next higher menu is caused automatically after pressing a softkey.

The right-hand supplementary menu is selected by pressing this key.
A supplementary menu cannot be selected from another supplementary menu but only via the main menu.

The labelling of all softkeys which call a submenu includes an arrow. Selection of a submenu is always effected via a softkey.

The softkeys are masked out in remote mode and during macro processing.

2.3.3 Setting the Parameters

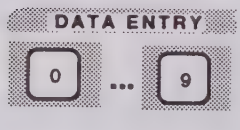
2.3.3.1 Data Entry

Instrument parameters can be entered in an entry window or in a table via the numeric keypad on the front panel (*DATA ENTRY*), an external keyboard and the roll-key.
The numeric keypad *DATA ENTRY* is provided for entry of numeric parameters (e.g., the start frequency). The roll-key is used for fast incrementing or decrementing of numeric parameters with a defined step size.

It is advisable to use the external keyboard for definition of alphanumeric parameters (e.g., file names) since the front panel does not allow for entry of letters. If no external keyboard is provided, the help line editor is called autormatically for entry of alphanumeric parameters.

2.3.3.1.1 Numeric Keypad on the Front Panel

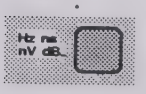
The keys are assigned the following functions:



Number keys

Changes the sign of the mantissa or exponent of a numeric parameter. A "-" is inserted at the cursor position in case of an alphanumeric parameter.

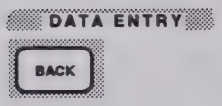
Inserts a decimal point "." at the cursor position in the numeric string.



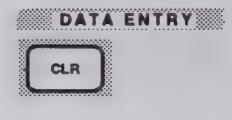
Provide the numeric value entered with the selected unit and terminate the entry.

The unit keys are all assigned the value "1" if quantities are indicated without dimensions in order to prevent faulty operations The unit keys thus adopt the function of an ENTER key. The same applies for an alphanumeric entry field.

Adds an exponent (E-xx) to the end of the numeric string.

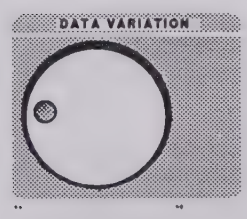


Deletes the character left to the cursor with numeric entry.
After entry has been terminated it allows for toggling between the current parameter and the previous value (UNDO function).



Exit from the entry window and removal from screen prior or subsequent to entry.
Complete deletion of the entry string just being entered during numeric entry.
Deletion of the system messages or warnings which are displayed in an individual field.

2.3.3.1.2 Roll-key and Cursor Keys



The roll-key has various functions.

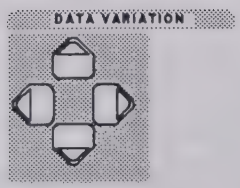
- With numeric entry, the instrument parameter is incremented (turning clockwise) or decremented (turning counterclockwise) at a defined step size.

  The step size may be equal to or smaller (e.g., 1/10) than the step size being defined for the cursor keys (see description of the *STEP* key).

- In tables, the roll-key can be used to shift the cursor horizontally or vertically when no entry window is open. The direction (horizontal/ vertical) is switched over using the cursor keys.
- The roll-key is used with the help-line editor to select the individual letters.
- It can be used to shift markers, display lines, limit lines etc.

The roll-key provides an acceleration algorithm, i.e., the variation step size increases with increasing rotational speed.

Cursor keys:



With numeric entry, the keys ⏶ or ⏷ are used to increase or decrease the instrument parameter by the selected step size. The keys are disabled With alphanumeric entry, the keys are used to toggle between the editing line and the help line editor.

The keys ◁ and ▷ are used to shift the cursor inside the entry window to reach a particular position in the number string.

In tables, the cursor keys are used to shift the cursor between the lines and columns of the table.

2.3.3.2 Entry Windows

2.3.3.2.1 Setting Up the Entry Window

The instrument parameters are not entered at the location where the parameter is displayed but in an individual entry window.

The entry window is called by a softkey or a hardkey and is used for definition of numeric or alphanumeric instrument parameters (START FREQUENCY by way of example):

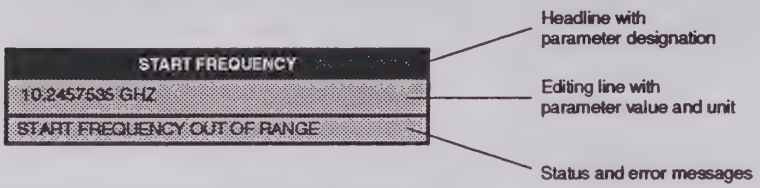

START FREQUENCY
10.2457535 GHZ
START FREQUENCY OUT OF RANGE
Headline with parameter designation
Editing line with parameter value and unit
Status and error messages

Fig. 2.3-8 Setup of an entry window

Subsequent to calling the entry window the current parameter value including the unit is displayed in the editing line. Status and error messges which refer to the current entry are displayed in the third and (optionally) fourth line.

The entry window is displayed in the left upper edge of the active measuring window with the default setting. When a mouse is connected to the instrument, open entry windows can be shifted to any position on the screen provided that they do not cover the softkey line. The new position is valid until measuring window is selected. The data entry window is represented transparent or non-transparent, as required.

Alphanumeric parameters are displayed as a simple character string in the editing line. Numeric parameters which consist of mantissa, exponent and unit are set up as follows:

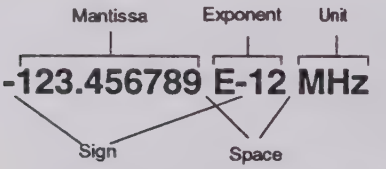


Fig. 2.3-9 Setup of numeric parameters

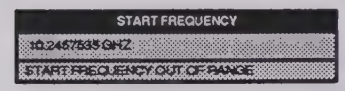
Mantissa: The first character is the sign of the mantissa, the positive sign is not displayed. The actual numeric value follows. The number of digits depends on the instrument parameter. The cursor may be shifted to the first digit of the mantissa at maximum, however, it may not precede the sign. The decimal point can be set as required.

Exponent: The exponent is separated from mantissa by a space character. The sign field of the exponent follows the "E", the positive sign "+" being not displayed similar to the representation of the mantissa. The cursor skips the "E" and the sign field. Two characters are fixed for the exponent value.

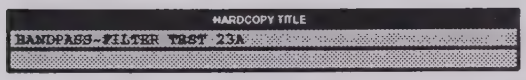
Unit: The unit (not represented in editing mode) is separated from the exponent by a space character.

The number of digits which can be entered for each instrument parameter is limited by the width of the input field only, but not by the amount which is physically enabled. (Example: Levels should be indicated with two decimals. The user may, however, enter as many decimals as desired - the entered value is rounded accordingly).

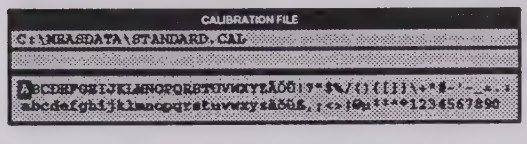
There are three types of entry windows:



The editing line of the entry window for numeric parameters allows for display of up to 24 characters. Horizontal scrolling is not possible in the editing line.



The editing line of the entry window for alphanumeric parameters allows for display of up to 60 characters (cf. display section). Maximum 256 characters may be entered. Horizontal scrolling is possible.



If no external keyboard is provided, the three-line entry window is replaced by a letter field which allows for individual selection of characters using the cursor keys (see help line editor).

2.3.3.2.2 Editing of Numeric Parameters

Calling the entry window:

- Subsequent to calling the entry window, the current value of the numeric parameter including the unit is displayed in inverted color. The cursor is not displayed in this state. The transparent data entry window has no background color.
- Pressing a number, sign or decimal point key causes the value and unit to be deleted. The new value is output left-justified. The cursor is positioned right to the last digit.
- Pressing the keys DATA VARIATION ◁ or ▷ causes normal representation of the current value. The unit is no longer displayed and the cursor precedes the first digit of the mantissa (◁) or follows the last digit entered (▷).
- The data management of the instrument stores the previous value of a parameter in addition to the current value. The BACK key allows for toggling between these two values.
- The entry window is closed upon pressing the key CLR.

Editing mode:

- In editing mode, the numeric value is read out without unit in a non-inverted form. The cursor is displayed.
- The individual characters are entered in insert mode. If the maximum amount of characters for the mantissa or the exponent has been entered, no further entry is possible (no horizontal scrolling). If characters are positioned to the right of the cursor, they are shifted right when reaching the maximum length and get lost.
- The DATA VARIATION keys ◁ and ▷ change the numeric value of the cursor. Pressing the DATA VARIATION keys △ or ▽ or the roll-key causes the original parameter value to be restored and modified according to the defined step size for this parameter.

Termination and abortion of entry:

- The editing mode is terminated by pressing a unit key. The validity of the new parameter value is checked and accepted for the instrument setting.
- The new value is displayed with its unit in the editing line of the entry window in inverted form. The cursor is not visisble. If an error occurs, a corresponding error message is displayed in the status line of the editing field, e.g., *"Out of range"*, *"Value adjusted"*, etc.
- Editing of a parameter can be aborted by pressing the key CLR. The original parameter is then displayed again.
- The entry window is closed by pressing the CLR key again. The entry window may be closed automatically upon correct entry, by way of exception.
- Pressing a key or softkey subsequent to starting the entry causes the entry to be aborted and the entry window to be closed. If the same softkey which has opened the entry window is activated during entry, the original value is restored and displayed.

2.3.3.2.3 Editing of Alphanumeric Parameters

Generally, the regulations for numeric parameters analogously apply for alphanumeric parameters. Note the exceptions given below:

- Alphanumeric parameters are not displayed with a unit.
- The four unit keys adopt the function of the ENTER key.
- Horizontal scrolling is possible in the editing line.
- Incrementing or decrementing cannot be effected via the keys ⏶, ⏷ or the roll-key.
- Pressing the sign key causes a "-" character to be inserted at the cursor position, the decimal point key causes insertion of a point ".".
- The exponent key has no function.

2.3.3.2.4 Help Line Editor

The help line editor allows for labelling or text entries to be made without an external keyboard being required. In this case, a field containing letters and special characters is added to the standard entry window. The help line editor is displayed automatically if no external keyboard is provided and an entry window for alphanumeric entry is opened.

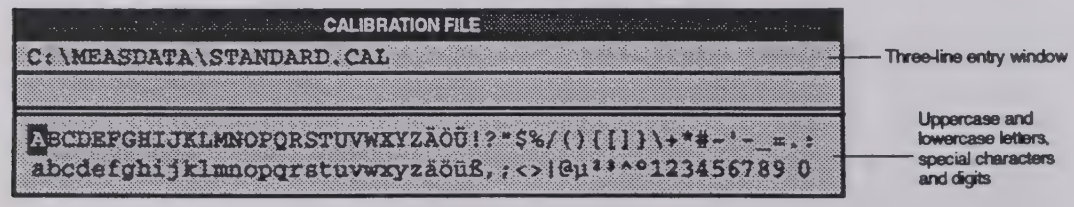


Fig. 2.3-10 Help line editor

- The keys ⌂ and ⌄ are used to toggle between the editing line and the help line editor.
- The cursor can be positioned to the required character in the help line editor using the cursor keys and the roll-key.
- A character is entered in the editing line by pressing any of the unit keys.
- If the cursor is already located in the editing line, pressing a unit key terminates data entry.

2.3.3.3 Table Entry

The FSE uses numerous tables for indication and configuration of instrument parameters. The tables differ very much in the number of lines, columns and inscriptions and have a different functionality.

Tables are represented in a non-transparent form. The size is predefined and cannot be modified. If a mouse is connected, the tables may be shifted on the display without covering the softkeys. Tables can be superimposed by entry windows or suchlike.

Tables are mostly coupled to a softkey menu which provides further functions for editing table entries, e.g., deletion of tables, copying lines or columns, marking of table elements, restoring of default states etc. Another kind of tables is exclusively used for indication of instrument parameters and cannot be edited.

The definition of individual tables and the operation of particular editing functions can be looked up in the reference section with the description of the corresponding softkey menu.

The basic concept of operation is, however, the same for all tables. A differentiation is made between shifting mode and editing mode.

2.3.3.3.1 Shifting Mode

This mode is active subsequent to opening a table. The **cursor** is shifted between the table elements by means of the cursor keys. The table element which is below the cursor is represented in inverted color.

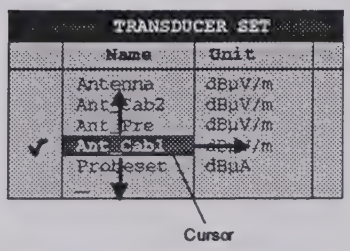


Fig. 2.3-11 Shifting mode

2.3.3.3.2 Editing Mode

A table element which is marked by a cursor can be editied as follows:

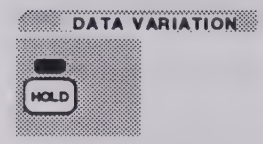
- by pressing one of the unit keys on the front panel or the *ENTER* key on the external keyboard.
- by a double-click of the mouse on the table element. If the clicked element is not yet marked by the cursor, the letter is positioned on the element, additionally.
- For numeric or alphanumeric instrument parameters, the editing operation may be started by entry of any number or letter on the front panel or on the external keyboard.

The data entry window, the selection list or the toggle editor are provided for this purpose.

After the editing operation has been terminated, the table enters the shifting mode again. The cursor is positioned automatically on the next table element.

2.3.4 Disabling the Control Elements - HOLD Key

The individual softkeys have the following functions:



The functions of the *HOLD* menu allow for disabling individual control elements or the complete instrument control. The LED above the *HOLD* key indicates that either the function *LOCK DATA* or *LOCK ALL* has been activated. The control can be enabled again by successively pressing the two *UNLOCK* softkeys in any order.

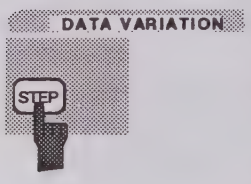
Switching off the instrument resets control such that the instrument can be normally operated again after subsequent switch-on.

After selecting the two UNLOCK softkeys, the instrument keyboard is enabled again. The LED above the HOLD key goes out.

Selection of this softkey causes the roll-key on the front panel and the keys ⏶ and ⏷ on the front panel and external keyboard to be disabled in order to prevent a parameter from being varied by mistake.

Selection of this softkey disables the complete front panel (including the *PRESET* key and roll-key, not including the *UNLOCK* softkeys), the mouse and all keys of the external keyboard. Exit from the *HOLD* menu is no longer possible. Control is enabled again by actuating the two *UNLOCK* softkeys.

2.3.5 Setting the Stepsize - STEP Key



A number of numeric instrument parameters allow for step-by-step incrementing or decrementing the value in the editing line of the entry window using the keys ⌓ or ⌔ or the roll-key. The stepsize used with the cursor keys can be specified for the selected parameters in the *STEP* menu.

The stepsize of an instrument parameter can only be varied when this parameter is edited in an entry window.

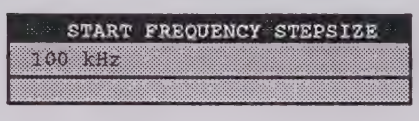
The key ⌓ leads to exit from the *STEP* menu and automatic return to the previously active menu.

This softkey causes the stepsize for the corresponding instrument parameter to be set automatically and be continuously varied with varying instrument settings (in accordance with other parameters).

Example:

- The stepsize of the *CENTER* frequency depends on the selected span.

This softkey calls an entry window for definition of a stepsize by the user. The parameter whose stepsize is varied, is displayed in the headline of the entry window:



The stepsize remains constant until a new value is entered. It is no longer coupled to other instrument parameters.

2.3.6 Mouse and External Keyboard Control

The connection of an external keyboard provides additional characters for the entry (letters and special characters). It is permitted to use both, front panel keys and the external keyboard, for control. The number, cursor and sign keys have the same effect as the corresponding front panel keys. A few keys of the external keyboard provide an extended functionality with entries or tables which is described in the Appendix E.

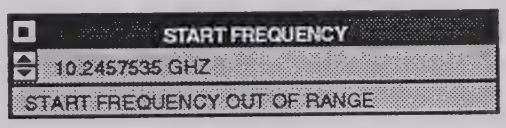
2.3.6.1 Data Entry Windows with Mouse Control

With a mouse being connected, additional functions are provided in the entry windows. Therefore, buttons are displayed in the entry window.

Essentially, the definitions which have been made for all types of entry window also apply for mouse control. However, note the following deviations:

- The so-called close-button is displayed on the left margin of the headline. Selecting this button via the mouse aborts the entry and closes the entry window. This corresponds to the function of the CLR key with manual control.
- In the numeric entry window, two buttons (⇕) are displayed on the left margin of the editing line. Simply clicking the buttons causes the parameter in the editing line to be incremented or decremented (similar to the keys ⌃ / ⌄ or the roll-key with manual control).
- IThe cursor can be positioned in the entry line by clicking a character using the mouse.
- A character in the letter window of the help line editor can be selected by a single click. A double click copies the character from the letter window into the editing line.
- Open entry windows can be shifted across the complete screen using the mouse; they must not, however, be superimposed on the softkey line. Shifting is performed by clicking the headline and pushing the mouse while he mouse-key is being pressed.

Example: Numeric entry window with mouse control



2.3.6.2 Mouse Control of Further Display Elements

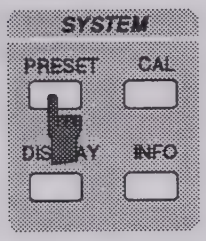
To increase operating ease, all display and control elements (enhancement labels, softkeys, function labels, display- und limit lines, etc.), which are indicated on the instrument, can be mouse-controlled.

Each display element is assigned exactly one softkey or hardkey, which may be used to specifiy the characteristics of this display element (see Appendix E).

If the display element is assigned a softkey, the menu which contains this softkey is entered by a double click on the display element.

2.4 General Configuration – *SYSTEM* and *CONFIGURATION* Key Groups

2.4.1 FSE Initial Configuration – *PRESET* Key



Using the *PRESET* key, the FSE can be brought to a predefined initial state equivalent to the state after power on. All previous setting are deleted if they were not previously saved in memory. Returning to the *PRESET* state is not critical with regard to an arbitrary signal which may still be present at the input as long as the signal is within the specified voltage range.

Pressing the *PRESET* key, causes the FSE to enter its initial state according to the following table:

Parameter	Setting			
	FSEA	FSEB	FSEM	
Mode	analyzer	analyzer	analyzer	
Center Frequency	1,75 GHz	3,5 GHz	13,25 GHz	
Center Frequency Step Width	350 MHz	700 MHz	2,65 GHz	auto, 0.1×Span
Span	3,5 GHz	7 GHz	26,5 GHz	
RF Attenuation	10 dB	10 dB	10 dB	auto
Ref Level	-20 dBm	-20 dBm	-20 dBm	
Level Range	100 dB log	100 dB log	100 dB log	
Detector	auto peak	auto peak	auto peak	
Sweep Time	5 ms	5 ms	100 ms	auto
Res BW	3 MHz	3 MHz	3 MHz	auto
Video BW	3 MHz	3 MHz	3 MHz	auto
Sweep	cont	cont	cont	
Trigger	free run	free run	free run	
Trace	1	1	1	clr write
Trace	2, 3, 4	2, 3, 4	2, 3, 4	blnk

2.4.2 Display Configuration – *DISPLAY Key*

The display of the measurement results on the FSE display screen takes place in either one or two measurement windows. If only one window is used, this window fills the complete display screen. Two measurement windows are always placed over each other. The axes labelling and measurement settings are defined independently in each measurement window.

When two measurement windows are used, the settings can be chosen to be either coupled or fully independent from each other. The measurement procedure is always sequential.

New instrument settings can only be entered in the active measurement window. This window is marked on the upper right corner of the grid. Coupled settings are changed simultaneously in both windows at the time of entry.

The entry of the measurement parameters for each of the two windows can be either independent from one another using numerical inputs, or by graphical definition of the span through the use of level and frequency lines. The former case, e.g., may be used for harmonic or frequency converter measurements, and the latter case, for a zoom display of a frequency or level segment.

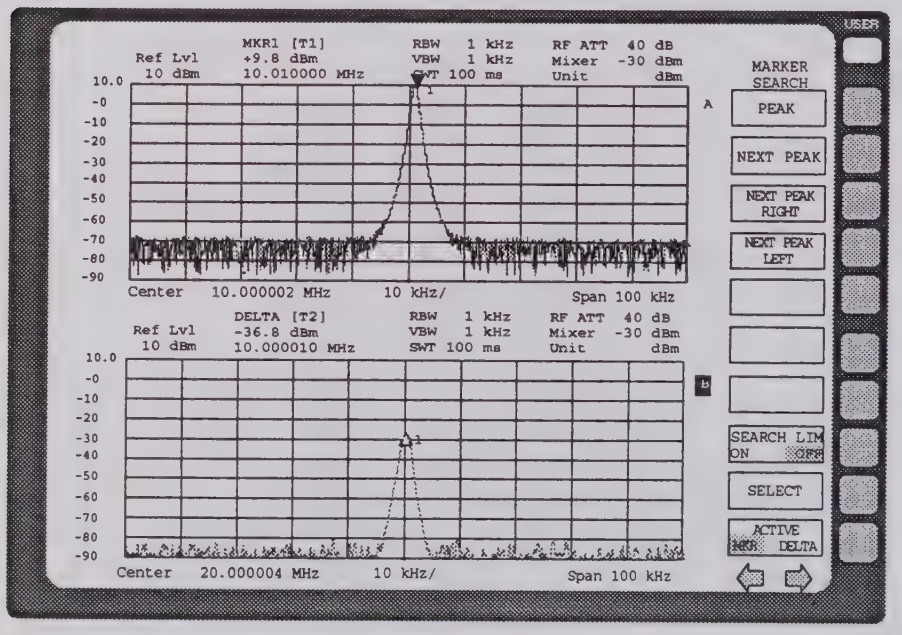
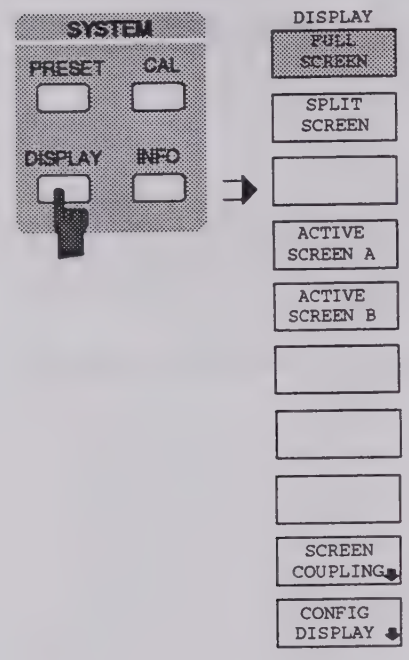


Figure 2.4-1 Split screen mode, screens uncoupled

SYSTEM DISPLAY menu:



The *DISPLAY* key calls a menu which is used to configure the display screen and to select the active measurement window in SPLIT-SCREEN mode.

2.4.2.1 Display Screen Mode Selection

SYSTEM DISPLAY menu:

The *FULL SCREEN* soft key configures the display screen to one measurement window. This is the default setting of the FSE.

In this mode, the *ACTIVE SCREEN A / ACTIVE SCREEN B* and *SCREEN COUPLING* soft keys are not used.

The *SPLIT SCREEN* soft key sets the display screen to show two measurement windows. The upper window is called *SCREEN A*, the lower is called *SCREEN B*.

If *SPLIT SCREEN* display is activated, the *ACTIVE SCREEN A* and *ACTIVE SCREEN B* soft keys are used to activate either window A or window B.

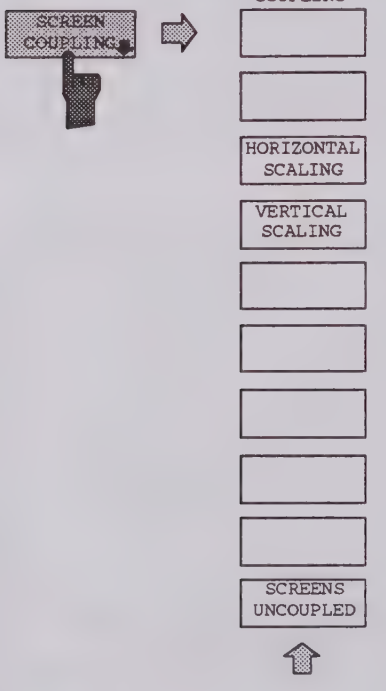
The entry of new settings is only possible for the active window.

When switching back to FULL SCREEN mode, the active measurement window is displayed.

2.4.2.2 Measurement Window Coupling

For the most part, the settings for the two windows can be either independently performed or coupled to one another. In many cases, when changes are made in one window (e.g., the reference level) it is desirable to also make the corresponding changes in the second window. The measurement window parameters which are to be coupled may be selected in the *SCREEN COUPLING* menu.

SYSTEM DISPLAY-SCREEN COUPLING submenu:



The *SCREEN COUPLING* soft key calls a sub-menu in which the coupling between the two measurement windows *SCREEN A* and *SCREEN B* can be defined. This coupling is only effective when both windows are displayed (*SPLIT SCREEN*).

In the default setting, all of the items which are selectable are also coupled.

The *HORIZONTAL SCALING* soft key switches the coupled scaling of the horizontal axes on and off.

ON In the frequency domain, the center frequency and the frequency span are identical. In the time domain, the sweep time for both windows is the same.

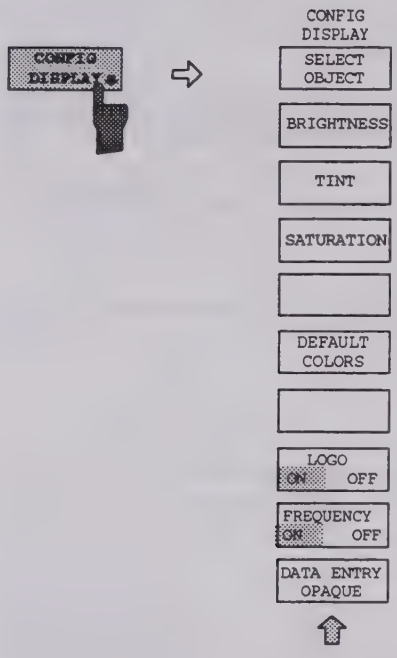
The *VERTICAL SCALING* soft key switches the coupled scaling of the vertical axes on and off.

ON For a level measurement, this means that the reference level and the vertical resolution (*LEVEL RANGE*) are set to the same values in both windows.

The *SCREENS UNCOUPLED* soft key switches all of the possible couplings between the measurement windows to off.

2.4.2.3 Display Screen Configuration

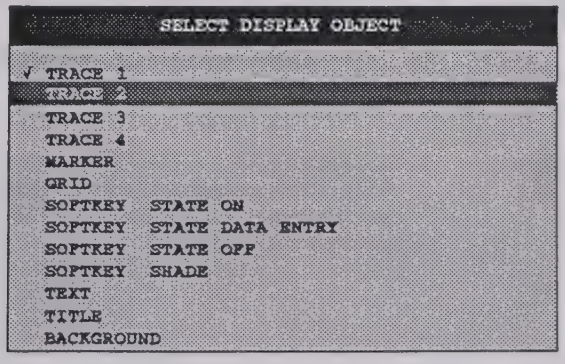
SYSTEM DISPLAY-CONFIG DISPLAY submenu:



The *CONFIG DISPLAY* soft key calls a submenu and its supplementary menu, in which the selection of color and brightness for the individual elements on the display screen takes place. The actual selection of the elements takes place in the corresponding menu table.

It is important to note that the color assignment of the soft keys is coupled with the color assignment of other display elements.
Changing for example the color of SOFTKEY STATE OFF causes the color of the table background to be changed at the same time. The same applies to SOFTKEY STATE DATA ENTRY and display lines, and to SOFTKEY STATE ON and enhancement labels.

The *SELECT OBJECT* soft key activates the SELECT DISPLAY OBJECT table, with which a graphics element can be selected. After selection, the brightness, tint and saturation of the selected element can be changed using the soft keys of the same name. The effect of the color changes can be seen immediately on the display screen.



The *BRIGHTNESS* soft key activates the entry of the brightness of the color for the selected element. The range of input values is 0 to 100%.

The *TINT* soft key activates the entry of the color tint of the selected element. The entered value is related to a continuous color spectrum ranging from red (0%) to blue (100%).

The *TINT* function is not available for monochrome (black/white) displays.

The *SATURATION* soft key activates the entry of the color saturation for the selected element.

The range of inputs is from 0 to 100%.

The *DEFAULT COLORS* soft key restores the default settings for brightness, color tint and color saturation for all display screen elements.

The *LOGO* soft key switches the Rohde & Schwarz company logo displayed in the upper left corner of the display screen on or off.

The *FREQUENCY* soft key switches the displaying of frequency information on the screen on and off.

ON Frequency information is displayed.

OFF Frequency information is not outputted to the display. This can be used for example to protect confidential data.

The *DATA ENTRY OPAQUE* soft key sets the data entry windows to opaque. This means that entry windows are underlayed with the background color for tables and that diagrams and traces behind an entry window can no longer be seen.

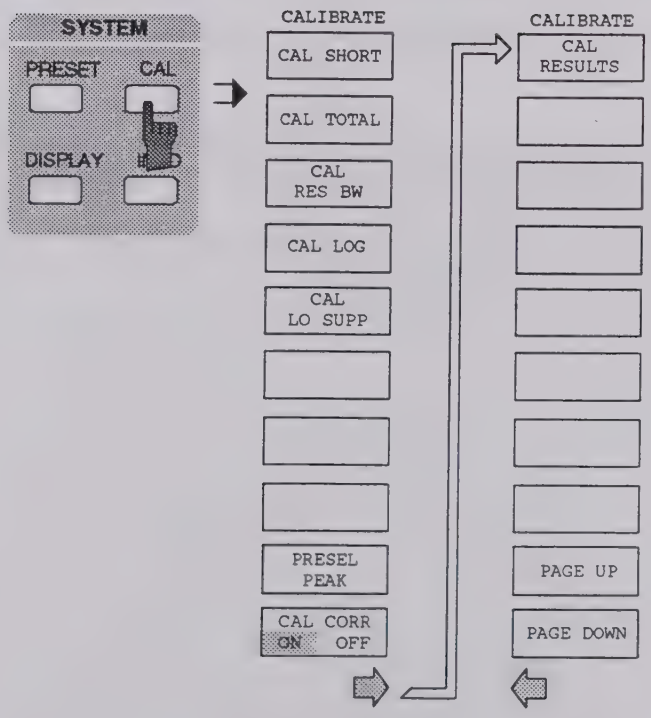
2.4.3 FSE Calibration – *CAL Key*

The FSE maintains its high measurement accuracy through the application of numerous self-calibration techniques. The *CAL* hard key provides a series of calibration functions which allow not only the calibration of the complete instrument, but also calibration functions which are specifically applicable to the measurement requirements of relevant instrument sections.

The measurement settings of the FSE are saved and, after calibration, completely restored. The calibration data valid before calibration are saved and, in case of a calibration abort, restored.

A window shows the progress of the calibration while it is running. ABORT can be used to abort the calibration at any time.

SYSTEM CAL menu:



The *CAL* key displays a menu with the available calibration functions.

2.4.3.1 Calibration Function Calls

SYSTEM CAL menu:

The *CAL SHORT* soft key starts a short calibration, in which the absolute gain of the analyzer as well as the gain compensation values of the selected bandwidth are corrected.

The *CAL TOTAL* soft key starts a complete calibration of the analyzer including additional partial calibrations shown in the menu.

UNCAL is displayed in the status line if calibration cannot be successfully completed or if the correction data are disabled (*CAL CORR* soft key= *OFF*).

The *CAL RES BW* soft key starts the correction of der Mittenfrequenz, der Bandbreite und the gain of the resolution filter.

The *CAL LOG* softkey starts the calibration of the linearity of the logarithmic amplifier.

The *CAL LO SUPP* softkey calibrates the compensation of the first oscillator at low frequencies. After calibration, the display of the internal oscillator at the frequency 0 Hz is very small.

It is recommended that the calibration be performed whenever sensitive measurements are to be made at low frequencies.

The softkey is only available on model 30 of FSE.

The *PRESEL PEAK* softkey optimizes the tuning of the preselector for input signals in the frequency range above 7 GHz.

This calibration should be used whenever signal levels in the frequency range above 7 GHz are to be measured and high accuracy is desired.

If a marker is not active when the *PRESEL PEAK* softkey is pressed, marker 1 is activated as the reference marker and placed on the signal maximum in the active trace. Otherwise the active marker is used.

The following window is displayed on the screen while the peaking function is running. The function can be aborted at any time using the *ABORT* line. In this case, the correction value determined at the factory is restored.

The input signal's signal-to-noise ratio must be at least 10dB in order that the peaking function runs properly. Otherwise, the preselector may be set incorrectly, which would cause level errors by subsequent measurements.

If the instrument setting (start/stop frequency, sweep time) is changed after *PRESEL PEAK* has been called, the correction value for the preselector determined by the function is no longer used. Instead, the correction value determined at the factory is restored.

The softkey is only available by those FSE models which have an input frequency range above 7 GHz.

The *CAL CORR ON/OFF* soft key switches the calibration data on/off.

ON The status message depends upon the results of the total calibration

OFF The message *UNCAL* appears in the FSE status line.

2.4.3.2 Calibration Results

SYSTEM CAL menu:

The *CAL RESULTS* soft key in the right-hand supplementary menu calls the *CALIBRATION RESULTS* table, which shows the correction data found during calibration.

The *CALIBRATION RESULTS* table contains the following information:

page 1:

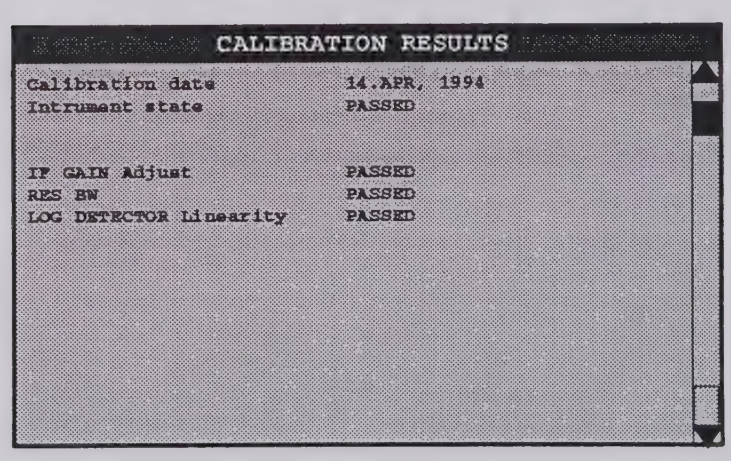
- date and time of the last total calibration
- overall results of the total calibration
- list of the calibration procedures with corresponding results

The following pages present:

- individual results according to function/module
- correction data according to function/module
- measurement values according to function/module

The results for the individual calibration procedures are categorised and displayed as follows:

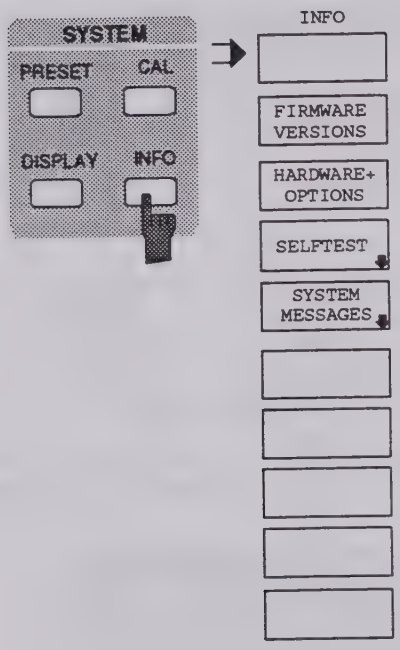
PASSED	calibration successful without restrictions
CHECK	deviations larger than expected, however, corrections could be performed
FAILED	deviations too large, no corrections were possible
ABORTED	calibration aborted



The *PAGE UP* and *PAGE DOWN* soft keys can be used to page through the table of calibration results.

2.4.4 Instrument Status and Measurement Parameters – *INFO Key*

SYSTEM INFO menu:



The *INFO* key is used to request general information concerning the instrument. These include:

- firmware version
- installed hardware options
- modification level of the individual modules
- self-test results with the option of calling self-test functions
- list of generated system messages

2.4.4.1 Firmware Versions

SYSTEM INFO menu:

The *FIRMWARE VERSIONS* soft key opens two tables, which provide the following informations:

- Table MODEL displays the exact instrument model.

MODEL
FSEA 20

- In the FIRMWARE VERSION table, the version of each software component installed in the instrument is listed. The versions of programmable logic devices are also included if the firmware version of the device can be determined.

FIRMWARE VERSION	
BIOS	1.15
ANALYZER	1.30
SERIAL NUMBER	123456

2.4.4.2 Hardware Configuration and Options

SYSTEM INFO menu:

The *HARDWARE+OPTIONS* soft key opens two tables in which the modules (INSTALLED COMPONENTS) installed in the instrument are listed.

- Table *MODEL* lists the instrument name and model:

MODEL
FSEA 20

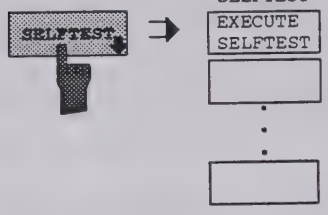
- Table *INSTALLED COMPONENTS* consists of four columns:
  COMPONENT name of module
  MODEL INDEX model number of the module
  MODIF INDEX modification index of the module
  HW CODE code for optional fitting of module components

  These lists contain only the modules which are actually present in the instrument, i.e., the modules which were identified by the module recognition software.

INSTALLED COMPONENTS			
COMPONENT	MODEL INDEX	MODIF INDEX	HW CODE
Main Processor	4	n/a	0
Graphic Board	4	n/a	0
I/O Board	4	n/a	0
FRAC SYN	4	0	4
RF Module	4	0	4
2nd IF Converter	3	2	2
Detector	4	0	2
IF Filter	3	2	3
Digital IF	2	0	2

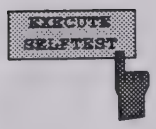
2.4.4.3 Self Test

SYSTEM INFO-SELFTEST submenu:



The *SELFTEST* soft key opens a submenu with which the self test can be started.

The instrument has extensive self test functions which comprehensively test instrument functionality. In case of a fault, the instrument can locate a defective module on its own. The self test sequence is described in more detail in chapter 4 (Maintenance and Troubleshooting).



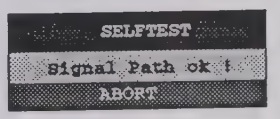
The *EXECUTE SELFTEST* soft key starts the test of the complete instrument. As the self test progresses, passed functions are displayed in a window.

The functions are tested in the following order:

1. Modules main CPU, digital motherboard, graphics and the interfaces

2. Reference frequency conditioning, the synthesizer modules and all LO signals

3. All RF, IF and signal-weighting modules



If no failure occurs during the execution of the self test, the following message is displayed when the complete self test is finished:

If a failure occurs during the execution of the self test, the self test is immediately aborted and a message indicating the defective module and the defective function is displayed:

The error message is stored, including date and time information, in a list containing all generated system messages (see next section). Further testing should be performed by an R&S service department.

2.4.4.4 System Messages

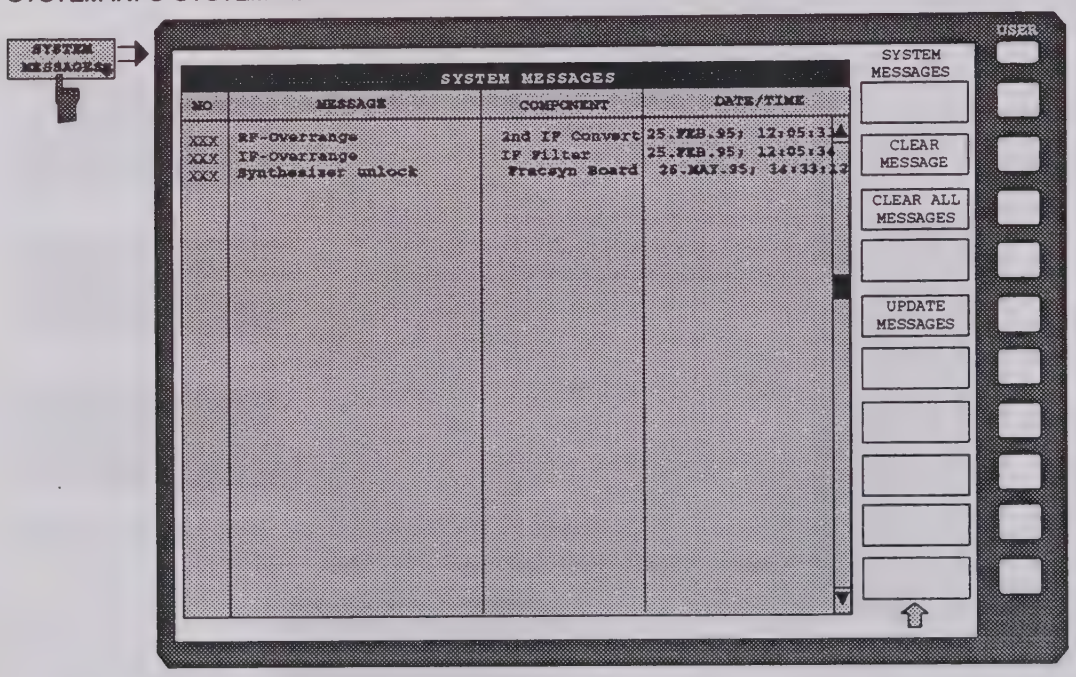
The *SYSTEM MESSAGES* soft key opens a submenu including a table in which the generated system messages are displayed. The most recent messages are at the top of the list.
The following information is presented:

NO	Device specific three digit error code (shown as XXX in the figure)
MESSAGE	Brief description of the reason for the message
COMPONENT	Hardware messages name of the affected module Software messages if needed, the name of the affected software components
DATE/TIME	Date and time of occurrence of the message

The system messages are displayed in various colors.

Red error message	The message has occurred since the last call to the *SYSTEM MESSAGES* menu,
Black error message	The message was already present at the last call.

SYSTEM INFO-SYSTEM MESSAGES submenu:



The *CLEAR MESSAGE* soft key deletes the message just selected.
All subsequent messages are shifted automatically one line upwards so that no empty lines exist. When the last message has been deleted, the selection bar also disappears.

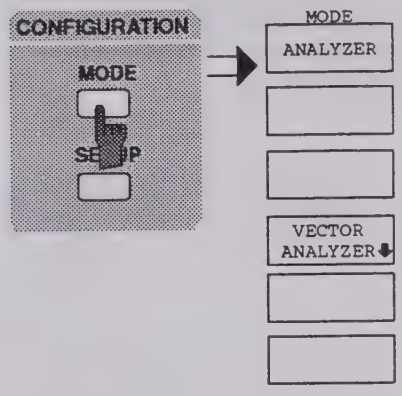
The *CLEAR ALL MESSAGES* soft key deletes all messages.

The *UPDATE MESSAGES* soft key causes all newly arrived messages to be entered at the top of the table.
At this time, all messages previously indicated as "new" are displayed as "old" messages

2.4.5 Mode Selection – *MODE Key*

The FSE can be operated in one of several modes, each of which is different with respect to functionality and control. The differences in control, however, consist not only in the enabling/disabling of additional soft keys within existing soft key menus, but rather in the fact that existing menus are completely replaced by new menus and menu trees which are tailored to the functional requirements. In the simultaneous application of two measurement diagrams, two modes are also simultaneously enabled. Each mode can be assigned to a measurement window.

CONFIGURATION MODE menu



The *MODE* key opens the menu for selection of the mode. Herein, the modes can be selected according to the available FSE options.

The *ANALYZER* soft key selects the *ANALYZER* mode.

This mode is the default setting of the FSE.

The functions provided correspond to those of a conventional spectrum analyzer. The analyzer measures the frequency spectrum of the test signal over the selected frequency range with the selected resolution and sweep time, or, for a fixed frequency, displays the waveform of the video signal.

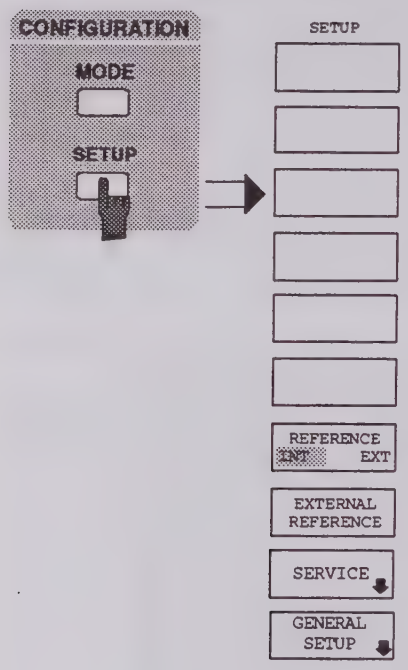
Softkey *VECTOR ANALYZER* selects the vector analysis mode.
The softkey is only available if FSE is equipped with Option FSE-B7.

In the vector analyzer mode FSE is automatically set to a fixed frequency (centre frequency) since vector analysis can only be carried out on one frequency.
The IF signal is digitized by the selected resolution bandwidth after filtering and mixed into the baseband by a digital mixer. Further processing is via digital signal processors which display the time characteristic of the amplitude or phase. As an option, the baseband can also be demodulated and the demodulated signal can be displayed. Principally any type of modulation (digital and analog) can be processed.

The functions of the analyzer mode are supplemented by the vector analysis functions which are described in detail in a separate manual to the option.

2.4.6 Preliminary Setup and Interface Configuation – *SETUP Key*

CONFIGURATION SETUP menu:



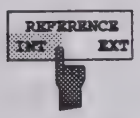
The *SETUP* key opens the menu for configuration of the FSE.
This menu contains the basic configurations for the measurement hardware applicable in all instrument modes as well as the interface configuration and features for setting date and time (GENERAL SETUP).

With the *SERVICE* soft key located in the menu on the right side of the display sceen, special setup functions are provided which, although not necessary in normal use, are useful in instrument service.

2.4.6.1 External Reference Oscillator

In general, the FSE can generate all internal oscillators from either the internal or an external reference oscillator. A 10 MHz quartz-controlled oscillator is used as the internal reference. A reference oscillator output is also available at the rear panel via the EXT REF IN/OUT connector.
This output can be used, e.g., to synchronise other instruments to the FSE. This connector can also be converted to an input connector for application of an external frequency standard. The FSE requires that the frequency of the external standard be entered so that the internal oscillators can be synchronised to it.

CONFIGURATION SETUP Menü:



The *REFERENCE INT EXT* soft key switches between the internal and external references.

The *EXTERNAL REFERENCE* soft key activates the entry of the frequency of the external source.
Range of input values is 1 MHz to 16 MHz in 1 MHz steps.

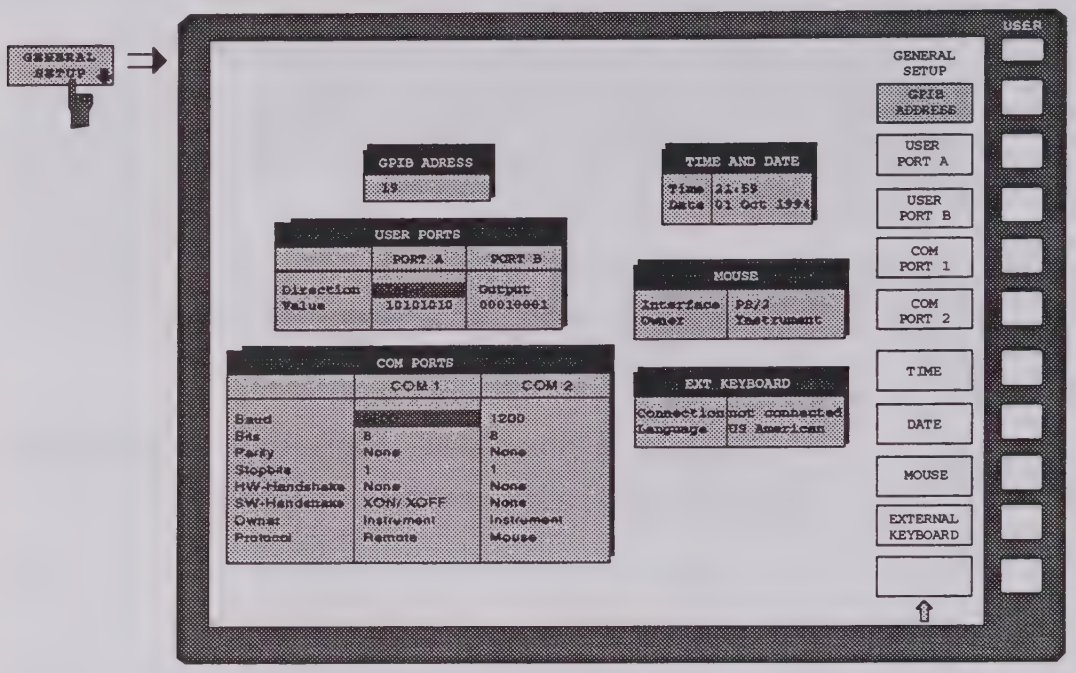
2.4.6.2 Programming the Interface Configuration and Time

The *GENERAL SETUP* soft key branches to a sub-menu in which the basic setup of general instrument parameters may be performed. In addition to the configuration of the digital interfaces (*IECBUS, COM, LPT* and *MOUSE*), the date and time, the selection of keyboard language as well as the configuration of the *USER PORTS* may be entered.

The current settings are displayed in tabular form on the display screen where they may then be edited.

Note: *Interface LPT cannot be configured. If the option FSE-B15, computer function, is installed, LPT1 can be used for printing in both the measurement instrument mode and the DOS mode. However, it can only be used for one mode at a time.*

CONFIGURATION SETUP menu:



2.4.6.2.1 IEC Bus Address Selection

CONFIGURATION SETUP-GENERAL SETUP submenu:

The *GPIB ADDRESS* soft key activates the entry of the IEC Bus address.

Permitted addresses are 0 through 30. The default setting is address 20.

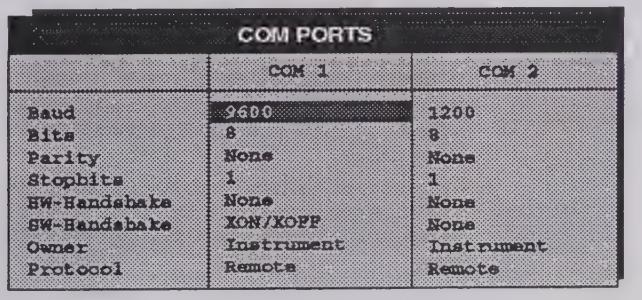
2.4.6.2.2 Serial Interface Configuration

CONFIGURATION SETUP-GENERAL SETUP submenu:

The *COM PORT 1* and *COM PORT 2* soft keys activate the columns COM1 and COM2, respectively, for entry of the serial interface parameters. Since the two interfaces are configured in the same manner, how to configure an interface is described in the following using *COM PORT 1*.

The following parameters need to be configured in the table:

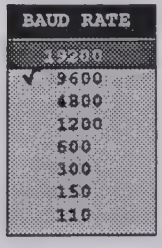
Baudrate	data transmission rate
Bits	number of data bits
Parity	bit parity check
Stopbits	number of stop bits
HW-Handshake	hardware handshake protocol
SW-Handshake	software handshake protocol
Owner	assignment to the measuring instrument or computer
Protocol	transmission protocol



Note: *A serial interface (COM1 or COM2) cannot be used for another purpose if a mouse is connected to it.*

***Baud* – Data transmission rate**

Allowed are the indicated values between 110 and 19200 baud. The default setting is 9600 baud.



***Bits* – Number of data bits per word**

For the transmission of text without German umlauts (Ä, ä, Ü, ü, Ö, ö) and special characters, 7 bits are adequate. For binary data as well as text with special characters or umlauts, 8 bits must be selected (default setting).

***Parity* – Bit parity check**

NONE	no parity check (default setting)
EVEN	even parity check
ODD	odd parity check

***Stopbits* – Number of stop bits**

Available are 0, 1 and 2. The default setting is 1 stop bit.

***HW-Handshake* – Hardware handshake protocol**

The integrity of data transmission can be improved through the use of a hardware handshake protocol which effectively prevents uncontrolled transmission of data and the resulting possible loss of data bytes. In the hardware handshaking procedure, additional interface lines are used to transmit acknowledge signals with which the data transmission can be controlled and, if necessary, stopped until the receiver is ready to receive data again.

A prerequisite for handshaking is, however, that the interface lines (DTR and RTS) are provided between sender and receiver. For a simple, 3-wire connection, this is not the case and hardware handshake cannot be realised here.

Default setting is *NONE*.

***SW-Handshake* – Software handshake protocol**

Besides the hardware handshake procedure using interface lines, it is also possible to achieve the same effect by using a software handshake protocol. Here, control bytes are transmitted in addition to the normal data bytes. These control bytes can be used, as necessary, to stop data transmission until the receiver is ready to receive data again.

In contrast to hardware handshaking, software handshaking can be realised even for a simple, 3-wire connection.

One limitation is, however, present in software handshaking. Software handshaking cannot be used for the transmission of binary data since, the control characters XON and XOFF require bit combinations that are also used for binary data transmission.

Default setting is *NONE*.

***Owner* – Assignment of the interface**

When the processor option FSE-B15 is installed, the serial interface can be assigned alternatively to the instrument measurement section, the DOS section or to both sections of the FSE.

If the interface is assigned to only one section of the instrument, it is not available to the other section.

INSTRUMENT	The interface is assigned to the instrument measurement section. Outputs to the interface from DOS are not possible and, so to say, land nowhere.
DOS	The interface is assigned to the DOS section. It cannot be used by the instrument measurement section. This means that hardcopy or remote control of the instrument via the interface is not possible. An attempt to start a print job via the interface results in an error message. The *PROTOCOL* parameter has no meaning in this mode.
INTR AND DOS	The interface is allocated to both instrument sections. It may be used alternately by each section. This means that a hardcopy job from the measurement section and a data transfer from DOS are not possible at the same time. This would lead to a mixing of the data streams. The set interface parameters, with the exception of *PROTOCOL*, are valid for both instrument sections. The *PROTOCOL* parameter is only of interest for the measurement section.

Note: *DOS programs cannot independently recognize changed interface parameter settings.*

***Protocol* – Transmission protocol**

The parameter allows the selection of special transmission protocols for measurement functions. The interface can be configured for:

- remote control as single instrument
- printer output (hardcopy)

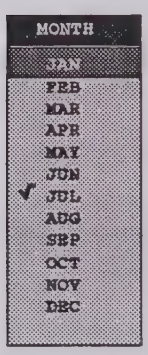
2.4.6.2.3 Setting Date and Time

CONFIGURATION SETUP-GENERAL SETUP submenu:

The *TIME* soft key activates the entry of time for the internal real time clock . In the corresponding dialog box, the time is partitioned into two input fields so that hours and minutes can be entered independently.

The *DATE* soft key activates the entry of the date of the internal real-time clock. In the corresponding dialog box, the date is partitioned into 3 input fields so that day, month and year can be input separately.

For the selection of the month, pressing a units key opens a list of abbreviations wherein the desired month can be selected.



2.4.6.2.4 External Keyboard Configuration

How to connect a keyboard is described in chapter 1, section "Connecting an External Keyboard", the operation of the instrument with an external keyboard is described in chapter 2, section "Mouse and External Keyboard Control".

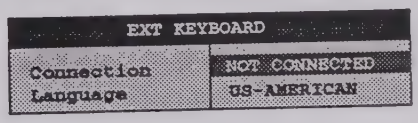
Caution:
The keyboard may only be connected when the instrument is switched off (STANDBY). Otherwise, correct operation of the keyboard cannot be guaranteed.

CONFIGURATION SETUP-GENERAL SETUP submenu:

The *EXTERNAL KEYBOARD* soft key activates the *EXT KEYBOARD* table for configuration of the external keyboard.

Connection Activation of the keyboard connection

Language Language definition for measurement instrument operation



***Connection* – Activating the connection**

Activating the connection mainly determines whether or not the help line editor is available.

CONNECTED A keyboard is connected. When an alphanumeric entry window is opened, the help line editor is no longer displayed automatically because it is no longer needed for editing.

NOT CONNECTED The help line editor is opened automatically when alphanumeric parameters are edited.

***Language* – Language definition for measurement instrument operation**

Available are US-American, German and French.

Note: *The language definition of the keyboard in DOS mode is independent of this setting and is determined by the appropriate MS-DOS command.*

2.4.6.2.5 Mouse Configuration

How to connect a mouse is described in chapter 1, section "Connecting a Mouse", the operation of the instrument with a mouse is described in chapter 2, section "Mouse and External Keyboard Control".

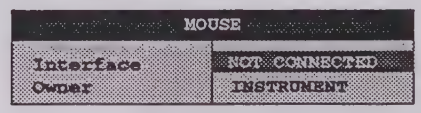
Caution:
The keyboard may only be connected when the instrument is switched off (STANDBY). Otherwise, correct operation of the keyboard cannot be guaranteed.

CONFIGURATION SETUP-GENERAL SETUP submenu:

The *MOUSE* soft key activates the *MOUSE* table for configuration of the mouse.

The following parameters need to be configured in the table:

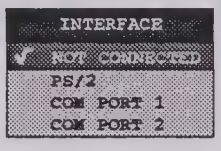
Interface	Selection of interface
Owner	Assignment of mouse



***Interface* – Selection of the interface**

If one of the serial interfaces is selected *(COM PORT 1* or *COM PORT 2)*, its interface parameters are automatically reconfigured so that mouse operation is possible.

NOT CONNECTED	No connection
PS/2	MOUSE connector on the rear panel
COM PORT 1	COM1 connector on the rear panel
COM PORT 2	COM2 connector on the rear panel

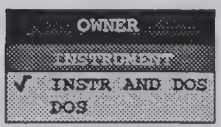


***Owner* – Assignment of the mouse**

If the processor option FSE-B15 is installed, the mouse can alternately be assigned to the instrument measurement section, the DOS section or to both sections simultaneously.

If the mouse is assigned to one section it is not available to the other section.

INSTRUMENT	The mouse is assigned to the instrument measurement section.
DOS	The mouse is assigned to the DOS section.
INTR AND DOS	The mouse is assigned to both sections.



2.4.6.2.6 User Port Configuration

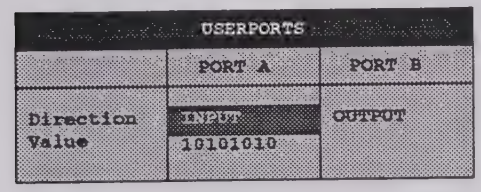
The instrument provides two parallel interfaces, each of which is 8 bits wide. Over these ports, arbitrary bit patterns can be output or input. The interfaces are designated *USER PORT A* and *USER PORT B*.

CONFIGURATION SETUP-GENERAL SETUP submenu:

The USER PORT A and *USER PORT B* soft keys activate the columns PORT A and PORT B, respectively, in the USERPORTS table for entry of the parameters for both of the parallel interfaces in the instrument. Because the two interfaces are configured in the same manner, how to configure an interface is described in the following using *USER PORT A*.

The following parameters need to be configured in the table:

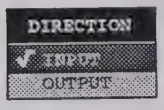
Direction	Direction of data transmission
Value	Indication/entry of current value



***Direction* – Direction of data transmission**

The *DIRECTION* parameter determines in which direction the interface transmits data.

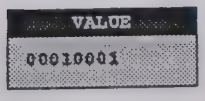
INPUT	read operation
OUTPUT	write operation



***Value* – Indication/Entry of current value**

The *VALUE* parameter shows the current value of the data at the port for data input as well as for data output. The displayed data is in binary format with the least significant bit (LSB) on the right.

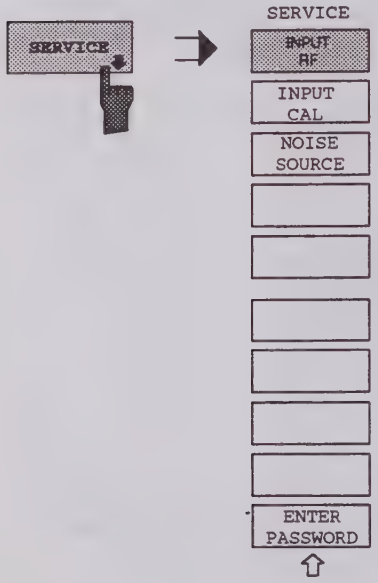
If the port is configured as an *OUTPUT* then, the displayed value can be edited. Data entry must also be in binary format (i.e., only the digits 0 and 1 are accepted).



2.4.6.3 Service Functions

The service menu offers a variety of additional function which are used in maintenance and/or trouble shooting. The service functions are not necessary for normal measurements, however, incorrect use can impair the functionality and/or data integrity of the FSE. Therefore, many of the functions can only be used after entering a password.

CONFIGURATION SETUP menu:



The *INPUT RF* and *INPUT CAL* softkeys are mutually exclusive selection switches. Only one switch can be active at any one time. They switch the input to the FSE between the *INPUT RF* connector (normal position) and the internal calibration source (120 MHz, -40 dBm).

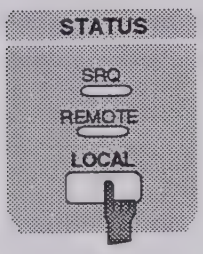
After *PRESET*, *RECALL* or FSE power on, the *INPUT RF* is always selected.

The *NOISE SOURCE* soft key switches on a noise source which is connected to the NOISE SOURCE connector on the instrument's rear panel.

The dc voltages on the connector are described in Annex A, section A.13.

The FSE contains a variety of service functions which, if incorrectly used, can impair the functionality of the analyzer. These functions are normally not accessible and are only usable after the entry of a password (*ENTER PASSWORD).*

2.5 Status Display-Remote/Manual Control – *STATUS Key Group*



The *SRQ* LED, the *REMOTE* LED and the *LOCAL*. key are contained in the *STATUS* key group.

- The *SRQ* LED indicates that a service request from the instrument has been asserted on the IEC Bus.
- The *REMOTE* LED indicates that the instrument is under remote control.
- The *LOCAL* key switches the instrument from remote to manual control, with the assumption that the remote controller has not previously set the LOCAL LOCKOUT function.

A change in the control mode consists of:

- **Enabling the Front Panel Keys**
  Under remote control, the soft-key menu is turned off and all keys, with the exception of *PRESET* and *LOCAL*, are disabled. Returning to manual mode enables all inactive keys. The soft key menu which is displayed is the main menu of the current mode.
- **Turning off the *REMOTE* LED**
- **Generating the message OPERATION COMPLETE**
  If, at the time of pressing the *LOCAL* key, the synchronisation mechanism via *OPC, *OPC? or *WAI is active, the currently running measurement procedure is aborted and synchronisation is achieved by setting the corresponding bits in the registers of the status reporting system.
- **Setting Bit 6 (User Request) of the Event Status Register**
  With a corresponding configuration of the status reporting system, this bit immediately causes the generation of a service request (*SRQ*) which is used to inform the software that the user wishes to return to front-panel control. This information can be used, e.g., to interrupt the control program so that the user can make necessary manual corrections to instrument settings. This bit is set each time the *LOCAL* key is pressed and is independent of whether or not the instrument is under remote or manual control.

- The *LOCAL* key aborts a running macro. The continuation of the macro is not possible.

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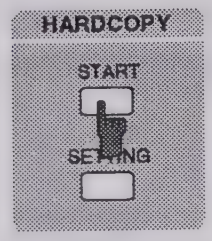
2.6 Measurement Documentation – *HARDCOPY* Key Group

2.6.1 Printing Data – *START* Key



The *START* key initiates the printing of measurement/ instrument status data.
The FSE can distinguish between two different output devices, each of which may be individually configured, e.g., a laser printer and a plotter. All documents are printed on the output device which is currently active.

Pressing the *HARDCOPY START* key initiates the print job. The printer parameters defined in the *HARDCOPY SETTINGS* menu are used for setting up the printer configuration. After pressing the *START* key, all of the display items to be printed are written to the printer buffer memory. Since the printer runs in the background, the instrument may be operated immediately after pressing the *START* key.

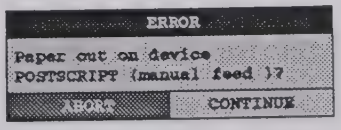
With *COPY SCREEN* selected in menu *HARDCOPY SETTINGS*, all the diagrams with traces and status displays are printed as they occur on the screen. Softkeys, open tables and data entry fields are not printed out. Function *COPY TRACE* allows to print out individual traces. With *COPY TABLE* tables can be printed out.

If the *FILE* option in the *HARDCOPY DEVICE* submenu of the *HARDCOPY SETTINGS* menu is selected then, upon pressing *HARDCOPY START*, the file name to which the output data are to be written is requested. For this an entry field is opened for entering the file name. If no external keyboard is connected, the help line editor is activated.

If the *START* key is pressed again while a print job is in progress, a new print job will be started directly after completion of the first one. It is not possible to process more than two hardcopies at the same time. With *START* pressed again, the following warning appears on the display screen:

Pressing the *OK* key causes the active print jobs to be interrupted. Selecting *CANCEL* erases the warning and the print job continues.

While a print job is in progress, problems may occur in the output device. If, while printing, the output device issues a PAPER OUT message, i.e., no more paper is available, the user will be prompted by the following message

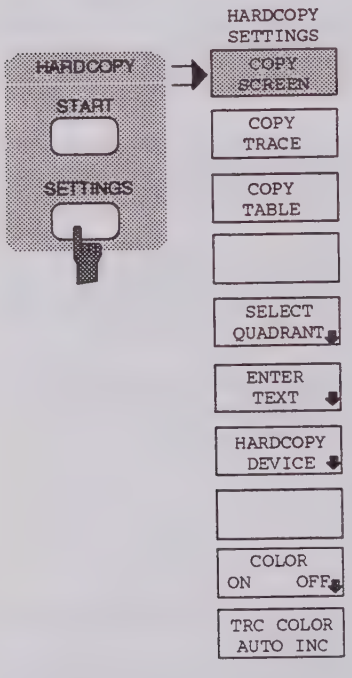


to load paper into the output device. The print job will then be either continued (CONTINUE selected) or aborted (ABORT selected).
Similar SYSTEM MESSAGES appear, e.g., if the IEC Bus address of the printer is incorrectly set , the printer does not respond, etc.

Switchover between b/w and coloured printouts is possible with softkey *COLOR ON/ OFF* provided that the printer connected is able to output such prints. The colours of the printout correspond exactly to those of the screen, ie a red trace will be output in red.
To change the colours of the objects on the printout, the screen colours have to be changed correspondingly in menu *DISPLAY*, submenu *CONFIG DISPLAY*. One exception is the colour of the background and the colour of the diagrams. The output background is always white irrespective of the screen colour and the diagrams are always black.
If several traces are to be output one after the other on the same sheet different colours can be chosen for each trace with the aid of softkey *TRC COLOR AUTO INC* (Trace Color Auto Increment).

2.6.2 Printing Configuration – *SETTINGS* Key

HARDCOPY SETTINGS menu:



The *SETTINGS* key opens the menu to define the output configuration for diagrams and measurement curves to the various output channels, e.g., printer, plotter or files.

The recommended procedure for configuring the output data is as follows:

- Configure the desired output device and select the interface over which the output is to take place by using the *HARDCOPY DEVICE* soft key.
- Select the display items to be printed via the *COPY SCREEN, COPY TRACE soft keys.*
- Select between coloured and b/w printouts via softkeys *COLOR ON/ OFF* and *TRC COLOR AUTO INC*
- Enter commentary applicable to the diagram or add a title for the overall print-out by using the *ENTER TEXT* soft key.
- Select the page format (*QUADRANT, FULL PAGE*) through use of the *SELECT QUADRANT* soft key.

The *COPY SCREEN, COPY TRACE* and *COPY TABLE* soft keys are selection switches, i.e., only one function can be enabled at any one time. The push buttons are used for selection only and do not initiate a print job. The actual printing of data is initiated by the *HARDCOPY START* key.

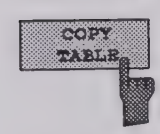
2.6.2.1 Selection of Displayed Elements and Colour Settings

HARDCOPY SETTINGS menu:

With softkey *COPY SCREEN* the output of test results is selected.

All the diagrams, traces, markers, marker lists, display lines, limit lines etc. are printed out as long as they are displayed on the screen. All the softkeys, tables and open data entry fields are not printed out. Moreover, comments, title, date, time entered at the bottom margin of the printout are output. The logo appears at the top left of the printout.

Using the *COPY TRACE* soft key, all curves visible on the display screen are printed out without auxiliary information. Specifically, no markers or display lines are printed.



Using the *COPY TABLE* soft key, all tables visible on the display screen are printed out.

With softkey *COLOR ON/ OFF* a coloured or b/w printout can be selected.

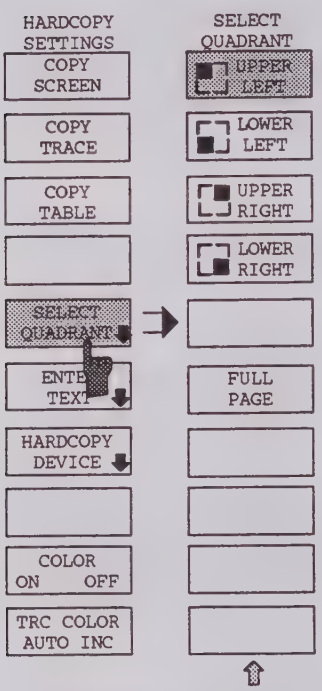
After having changed the printer driver or the hardcopy device (in submenu, *HARDCOPY SETTINGS*) the softkey is automatically switched to *ON*.
One exception is printer driver HP PCL4 which only supports b/w printouts. In this case, the softkey cannot be operated.

Softkey *TRC COLOR AUTO INC* automatically switches the colours of the traces on to the next printout. On the second printout, trace 1 has the colour of trace 2, trace 2 the colour of trace 3 etc. The fourth printout starts with the first colour. With the softkey switched off, the colours of the traces are reset to their original state.

When changing the printer driver or the hardcopy device (both in submenu *HARDCOPY SETTINGS*) as well as the selection b/w printout (softkey *COLOR ON/ OFF* in position *OFF*), softkey *TRC COLOR AUTO INC* is switched off.

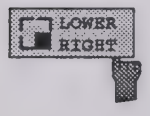
2.6.2.2 Selection of Hardcopy Format

HARDCOPY SETTINGS-SELECT QUADRANT submenu:



With the functions of the *SELECT QUADRANT* menu, the location of the display screen graphics on the printed page can be selected.

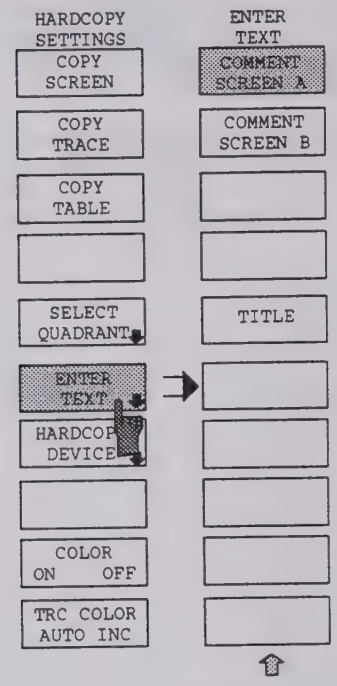
The *FULL PAGE* soft key switches quadrant printing off, i.e., printing now takes place at full size. The information as to which quadrant was last selected is also lost. *FULL PAGE* is the default setting.



The *UPPER LEFT, LOWER LEFT* as well as *UPPER RIGHT, LOWER RIGHT* soft keys select the page quadrants where the printed data will be positioned. In this case, the actual size of the data printed on the page is reduced to 25% of normal size. This reduction is independent of how the graphics are distributed on the display screen. Thus, for two measurement windows (*SPLIT SCREEN*), both measurement diagrams shown on the display are placed in the chosen quadrant. Thus, up to a maximum of 8 measurement windows can be printed on one page. (4 print commands for a *SPLIT SCREEN* display, each to a different quadrant)

2.6.2.3 Entry of Comment Text

HARDCOPY SETTINGS-ENTER TEXT submenu:



With the functions of the *ENTER TEXT* menu, commentary for individual windows can be entered. The comment text appears in the print-out, but does not appear on the display screen.

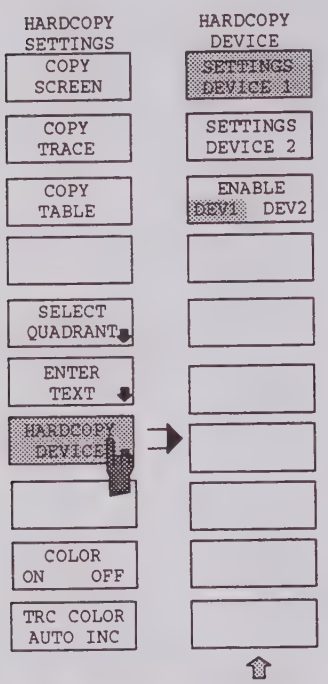
If a comment is not to appear on the printout, it has to be deleted.
By pressing *PRESET*, all comments will be deleted.

The *COMMENT SCREEN A* soft key opens an entry field in which a comment of two lines (60 characters per line) can be entered pertinent to the applicable window. If the user enters more than 60 characters, the excess characters appear on the second line on the print-out. Note: at any point, a manual line-feed can be forced by entering the @ character. The commentary is printed below the corresponding diagram. The *COMMENT SCREEN B* key has the same effect in measurement window 2.

The *TITLE* soft key activates a single line entry box for entering a title for the complete print-out with a maximum of 60 characters.

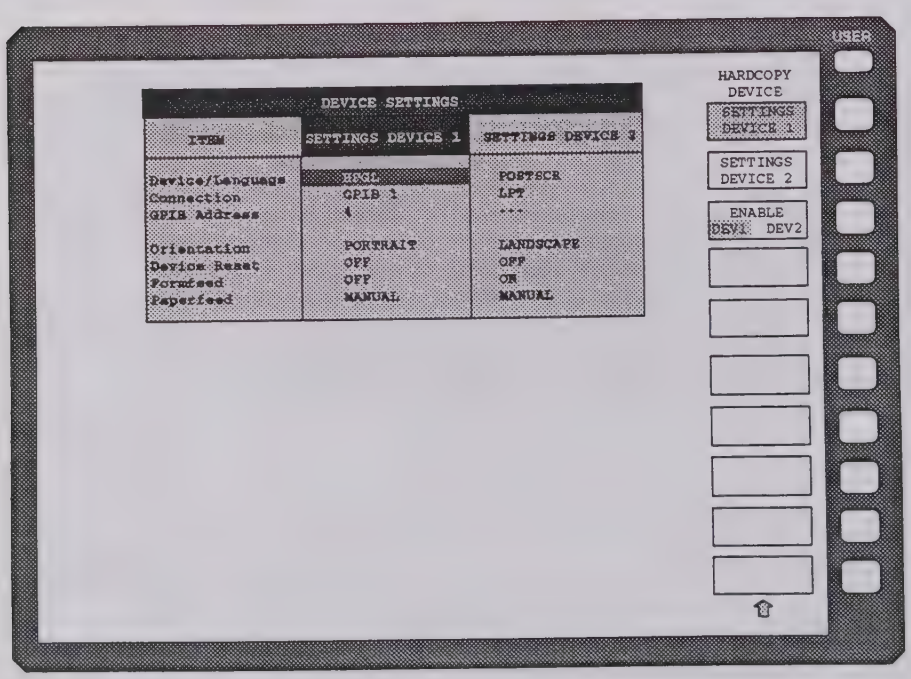
2.6.2.4 Selection and Configuration of the Output Device

HARDCOPY SETTINGS-HARDCOPY DEVICE submenu:



The *HARDCOPY DEVICE* soft key switches to the sub-menu which is used for the selection/configuration of the two output devices and for the connection of the devices to an output medium.

When the sub-menu is called, the corresponding table is simultaneously displayed. The *SETTINGS DEVICE 1* soft key is active and the selection bar is located at the *DEVICE/LANGUAGE* line in the corresponding column of the table.



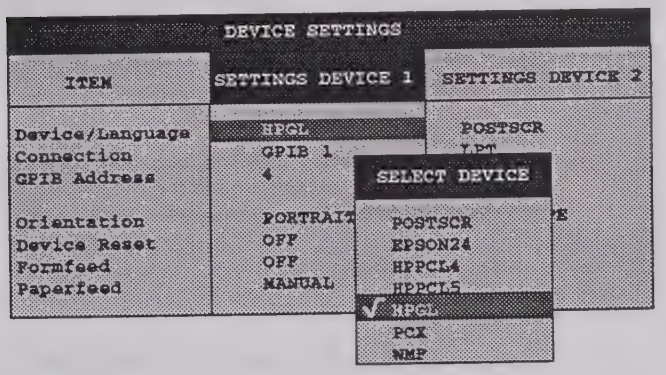
The FSE permits two different output devices to be configured. One of the devices is defined as the active device and can be used for hardcopies.

After calling the menu, the *SETTINGS DEVICE 1* soft key is active and permits the selection and configuration of the output device DEVICE 1. The selection bar is placed the corresponding column of the table. The *SETTINGS DEVICE 2* soft key is used to configure DEVICE 2.

The actual selection of the active output device takes place with the *ENABLE DEV1 DEV2* soft key in the *HARDCOPY DEVICE* sub-menu.

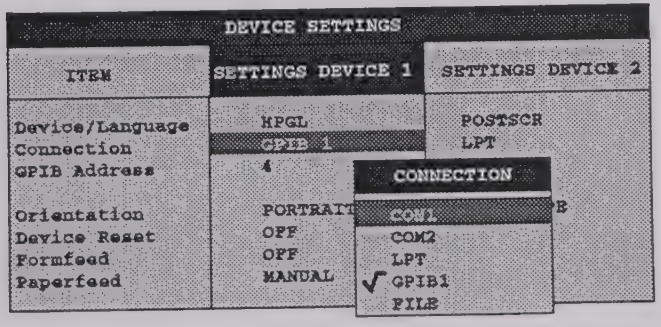
Device/Language

The selection of the output device/language for DEVICE 1 and DEVICE 2 is made in this line. Sequence, number and name of available devices depends on the driver files stored on the harddisk.



Connection

The output channel to which the output device is connected is defined in this line.

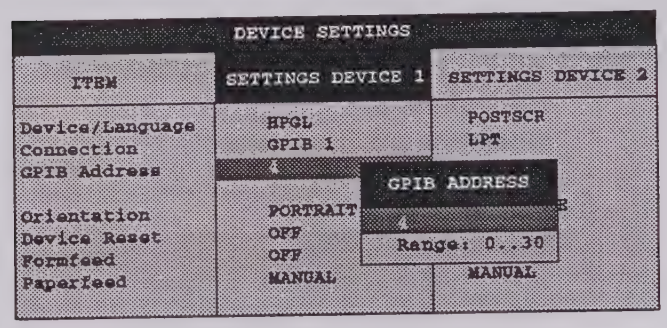


By selection of the *FILE* channel, the printer output can be sent to a file. In this case, pressing *HARDCOPY START* results in a prompt for the entry of a file name.

Output channels which, at first glance, do not appear to make sense, are also permitted because, in some cases, adapters are available which allow these devices to be connected to the interface. For example, adapters for RS232 ↔ IECBUS are available.

GPIB Address

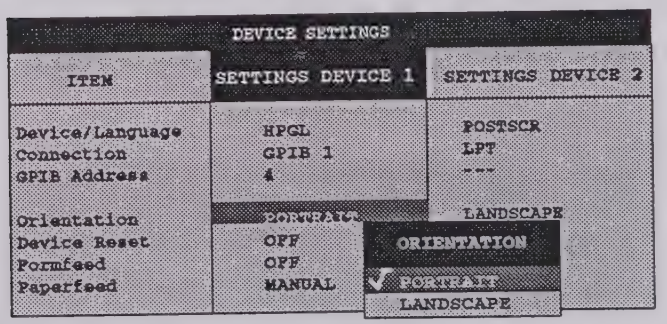
The IEC Bus address of the output device is set in this line .



The entry field in the GPIB line can only be opened when GPIB 1 was selected as an output channel in the connection line. Otherwise, this field is blank and can not be reached with the cursor keys.

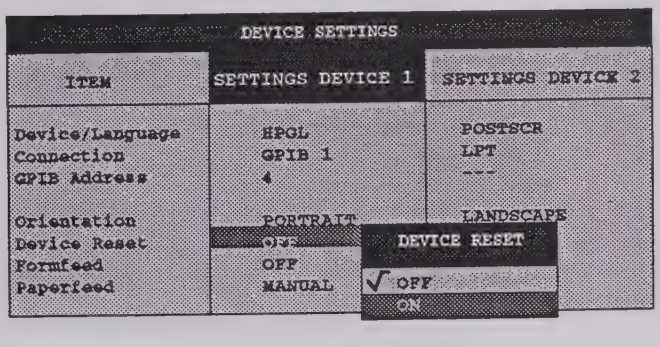
Orientation

In this line, the print format of the output page is set to either vertical (= PORTRAIT) or horizontal (= LANDSCAPE).



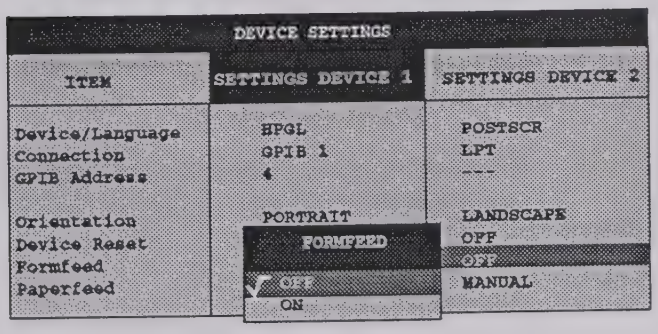
Device Reset

This line defines if the output device is to be reset (*DEVICE RESET ON*) before the actual print job is started or not (*DEVICE RESET OFF*). Resetting the output device causes, e.g., the loss of any settings which are made directly on the output device. For example, the definition of the drawing range for plotters or the print resolution for printers. The default setting at delivery is, therefore, *DEVICE RESET OFF*



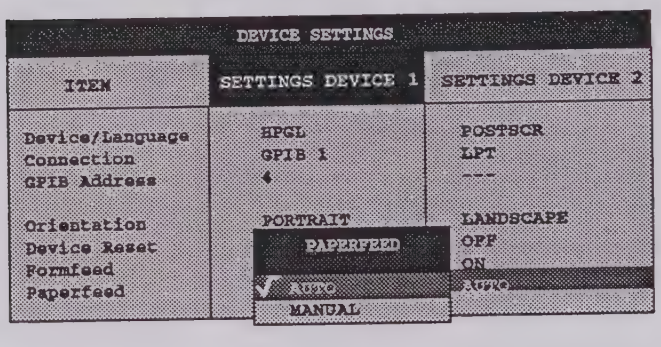
Formfeed

This line of the table determines whether a formfeed is made (*FORMFEED ON*) at the completion of the print job or not (*FORMFEED OFF*). The entry field in this line can only be selected when the output device permits a formfeed. Therefore, for plotters, it is set to OFF and cannot be changed.

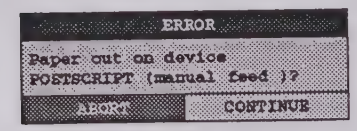


Paperfeed

This line of the table determines which paper holder is to be used for the print job. The input field of this line can only be selected when the output device permits a selection between endless and single-sheet paper types. Therefore, for plotters it is set to OFF and cannot be changed.



MANUAL FEED implies selection of the single-sheet mode so that, after pressing *HARDCOPY START*, the print job is stopped after each page and the user is prompted by the message



to load a new page in the output device. The print job is then either continued (CONTINUE selected) or stopped (ABORT selected).

The *ENABLE DEV1 / DEV2* soft key determines the active output device. The default output device is DEVICE 1, i.e., all output takes place on DEVICE 1.

2.7 Saving and Recalling Data Sets – *MEMORY* Key Group

The keys in the *MEMORY* group call the following functions:

- Functions for management of storage media (*CONFIG*). Included are among others functions for listing files, formatting storage media, copying, and deleting/renaming files.
- Storage/loading functions for storing (*SAVE*) instrument settings such as instrument configurations (measurement/display settings, etc.) and measurement results from working memory to permanent storage media, or to load (*RECALL*) stored data into working memory.

The FSE is capable of internally storing complete instrument settings with instrument configurations and measurement data in the form of data sets. The respective data are stored on the internal hard disk or, if selected, on a floppy. The hard-disk and floppy-disk drives are assigned logical names as usual in PC applications:

floppy disk A:
hard disk C:

In addition to the saving and recalling of complete instrument settings, it is also possible to save/recall subsets of settings. Configuration data and measurement values are stored in separate files. These files have the same name as the data set but however have a different extension. A data set thus consists of several files which have the same name but different extensions (see table 2.7-1).

When saving or loading a data set, the subsets which are to be saved or loaded can be selected in the corresponding menus. This makes it easy to reconstruct specific instrument settings.

When saving and loading data via the *SAVE* and *RECALL* menus, partial data sets are selected in a table in the sub-menu *SEL ITEMS TO SAVE/RECALL*. The relationship between the designations in the table and the contents of the partial data sets is shown in table 2.7-1.

The saved files of the data sets can be copied from one storage medium (e.g. drive C:) to another storage medium (e.g. drive A:) or to another directory using the functions found in the *MEMORY CONFIG* menu. File names and extensions must however not be changed. The relationship between the partial data sets and the extensions is shown in table 2.7-1.

Table 2.7-1 Relationship between extensions, contents and designations of partial data sets

	Extension	Contents	Designation in the table SEL ITEMS TO SAVE/RECALL
Configuration data:	.SET	current settings of the measurement hardware and the related title, if present	HARDWARE SETTINGS
	.LIN	data-point tables for the active limit lines	LINES
	.CFG	current configuration of general instrument parameters	GENERAL SETUP
	.HCS	configuration for hardcopy output	HARDCOPY
	.COL	user-defined color settings	COLOR SETUP
Measurement results:	.TR1....4	measurement data trace 1 to trace 4	TRACE1...4

2.7.1 Configuration of Memory – *CONFIG Key*

MEMORY CONFIG menu:

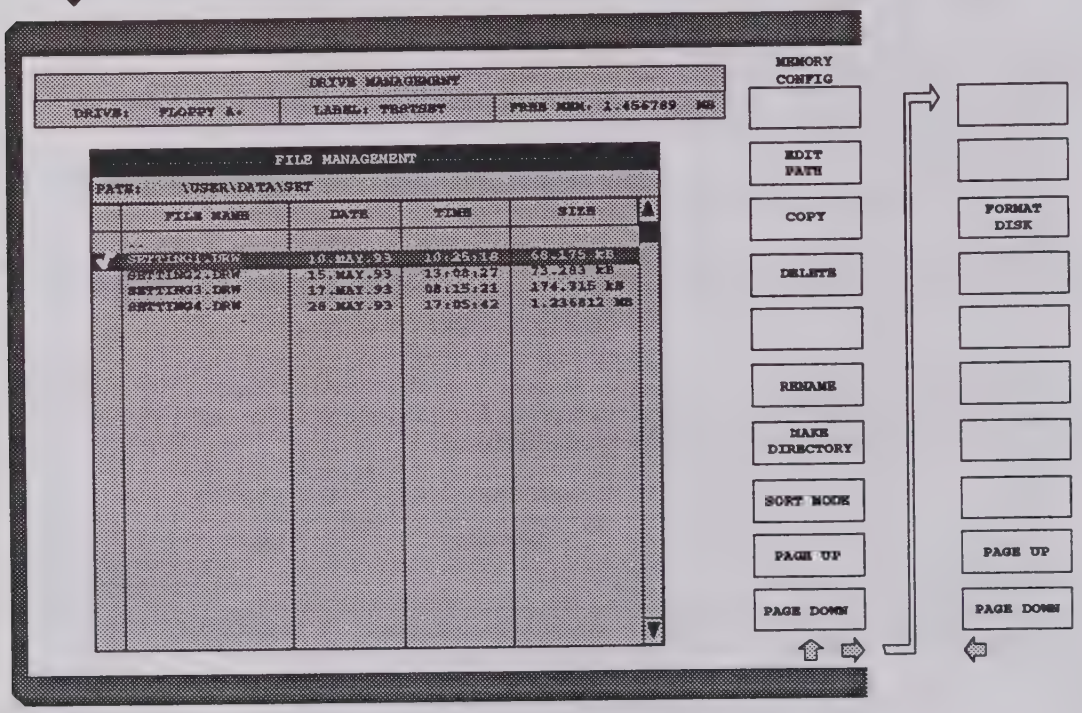
The *CONFIG* key opens a menu for managing storage media and files.

Table *Drive Management* displays the name and label of the storage medium as well as the available storage area.

Table *File Management* displays the files of the current directory and indicates if any subdirectories are present.

If a directory name is selected, the FSE automatically changes to this directory. Selection of the entry '..' moves the FSE to the next higher directory level.

Note: *It is not possible to change menus as long as a file operation is running.*

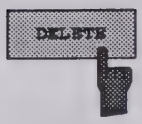


The *EDIT PATH* soft key activates the input of the directory which will be used in subsequent file operations.

The new path is included in the *FILE MANAGEMENT* table.

The *COPY* soft key activates the input of the destination of the copy operation.

By entering a predefined disk drive (e.g. C:), a file can also be copied to another storage medium. The files/directories selected by the cursor are copied after the input is confirmed by pressing the *ENTER* key.



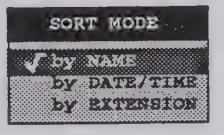
The *DELETE* soft key deletes the selected files.
To prevent accidental deletion of data, confirmation by the user is requested.

The *RENAME* soft key activates the entry of a new name for the selected file or directory.

The *MAKE DIRECTORY* soft key creates directories/sub-directories. Sub-directories are recommended for sorting files on the storage medium so that the structure is easier to comprehend.

The entry of an absolute path name (e.g.; "\USER\MEAS") as well as the path relative to the current directory (e.g., "..\MEAS") is possible.

The *SORT MODE* soft key activates the selection of the criteria according to which the files listed in the *FILE MANAGEMENT* table may be sorted.



Directory names are located at the top of the list after the entry for the next higher directory level ("..").

The *PAGE UP* or *PAGE DOWN* soft key sets the *FILE MANAGEMENT* table to the next or the previous page.

The *FORMAT DISK* soft key formats diskettes located in drive A:.
To prevent accidental destruction of diskette data, confirmation by the user is requested.

2.7.2 Saving Data Sets – *SAVE Key*

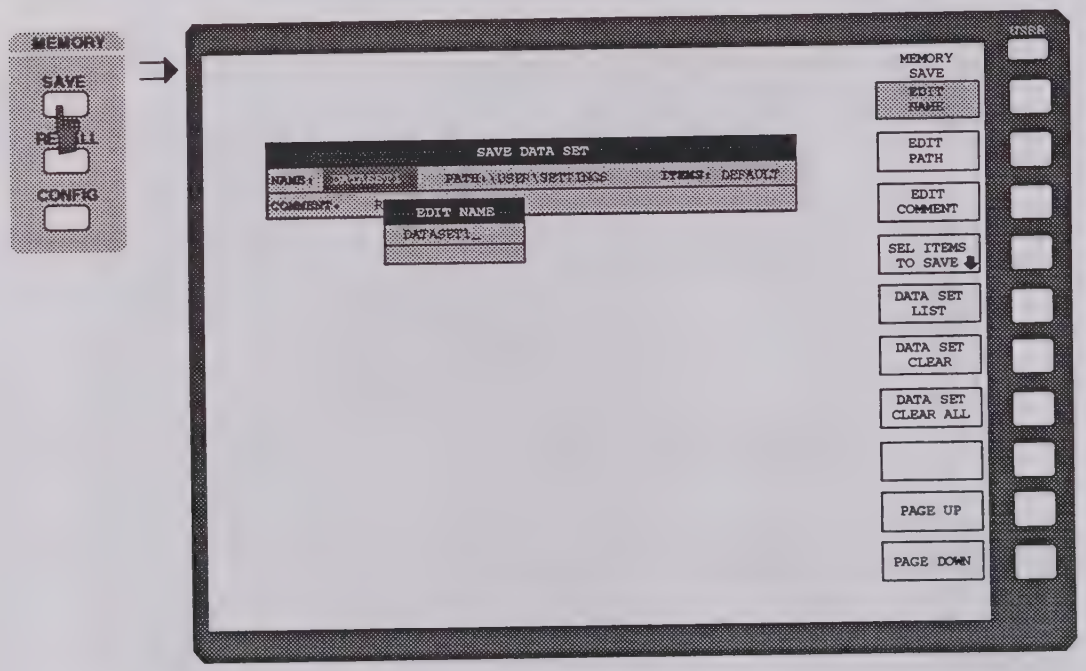
The *SAVE* key activates a menu which contains all functions necessary for saving instrument data.

- Entry of the name of the data set which should be saved. Confirmation of the entry initiates a save operation to store the data set.

  Data set names may contain both alphabetical and numeric characters, in the simplest case only numbers. The simplest example for the input of a data set name is illustrated by the following key strokes:

  <SAVE> <1> <units key>
- Entry of the directory in which the data set should be saved
- Input of data set description
- Selection of the partial data sets to be saved (sub-menu SEL ITEMS TO SAVE)
- Indication of all available data sets
- Deletion of all available data sets

MEMORY SAVE menu



The *SAVE DATA SET* table shows the current settings regarding the data set:

Name	name of data set
Path	directory in which the data set will be saved
Items	indicates whether the default selection of the partial data set (DEFAULT) or a user-defined selection (SELECTED) will be saved
Comment	Commentary regarding the data set

The *EDIT NAME* soft key for entering the name of the data set to be saved is activated automatically.

2.7.2.1 Selecting the Data Set for Storage

MEMORY SAVE menu:

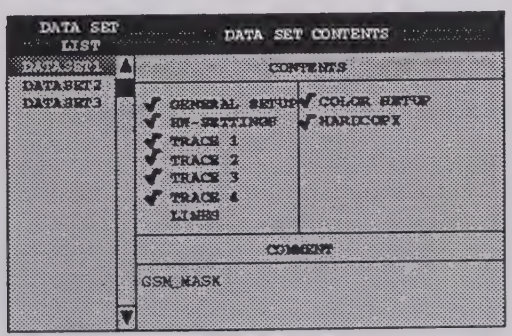
The *EDIT NAME* soft key activates the entry of the name of the data set to be saved.

Data entry is concluded by pressing one of the units keys which initiates a save operation to store the data set.

The *EDIT PATH* soft key activates the input of a directory name where the data sets are to be stored.

The *EDIT COMMENT* soft key activates the entry of commentary concerning the current data set. A total of 60 characters are available for this purpose.

The *DATA SET LIST* soft key opens the *DATA SET LIST/CONTENTS* table. In addition, the *DATA SET CLEAR* and *DATA SET CLEAR ALL* soft keys are displayed.



The *DATA SET LIST* column lists all of the data sets which are stored in the selected directory.

The *CONTENTS* and *COMMENT* lines in the *DATA SET CONTENTS* column indicate the saved partial data sets and the commentary for the currently selected data set.

Note: *The current instrument configuration can be easily stored under the name of an existing data set:*

➢ *Press a units key after selecting a data set*

The name and the selection of the partial data sets for the currently selected data set will be placed in the SAVE DATA SET table. The DATA SET LIST table is closed and, instead, the entry field for the EDIT NAME function with the name of the selected data set is opened.

➢ *Press a units key.*
The current instrument configuration is saved as a data set under this name.

The *DATA SET CLEAR* soft key deletes the marked data set.

The *DATA SET CLEAR ALL* soft key deletes all data sets in the current directory.

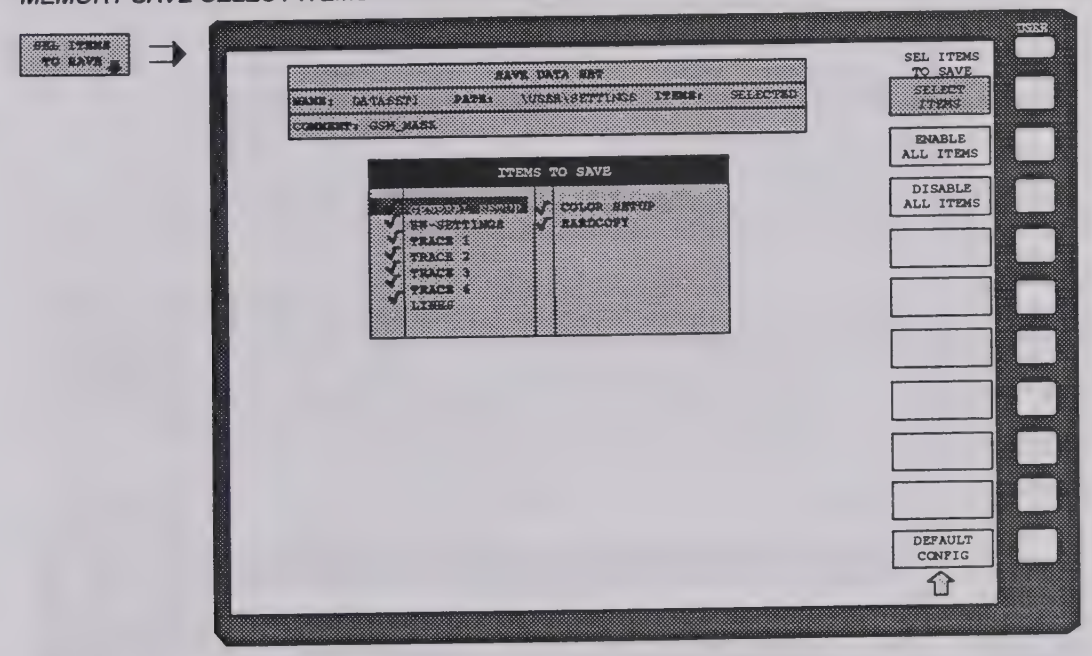
Since, in this case, all available data sets are lost, confirmation by the user is required.

The *PAGE UP* or *PAGE DOWN* soft key sets the *DATA SET LIST* table to the next or previous page.

2.7.2.2 Selecting the Partial Data Set for Storage

The *SEL ITEMS TO SAVE* soft key opens a sub-menu for selection of the partial data sets.

MEMORY SAVE-SELECT ITEMS TO SAVE sub-menu:



The *ITEMS TO SAVE* table displays the selectable partial data sets:

General Setup	current configuration of general instrument parameters
HW-Settings	current measurement hardware settings
Trace1...4	measurement data trace 1 to trace 4
Lines	data point tables for the active limit lines
Color Setup	user-defined color settings
Hardcopy Setup	configuration for hardcopy output

The *SELECT ITEMS* soft key moves the selection bar to the first line, left column of the table.

The *ENABLE ALL ITEMS* soft key marks all entries in the *ITEMS TO SAVE*. table.

The *DISABLE ALL ITEMS* soft key unmarks all entries in the *ITEMS TO SAVE* table.

The *DEFAULT CONFIG* soft key establishes the default selection of the partial data set to be saved and outputs *DEFAULT* in the *ITEMS* field of the *SAVE DATA SET* table.

2.7.3 Recalling of Data Sets – *RECALL* Key

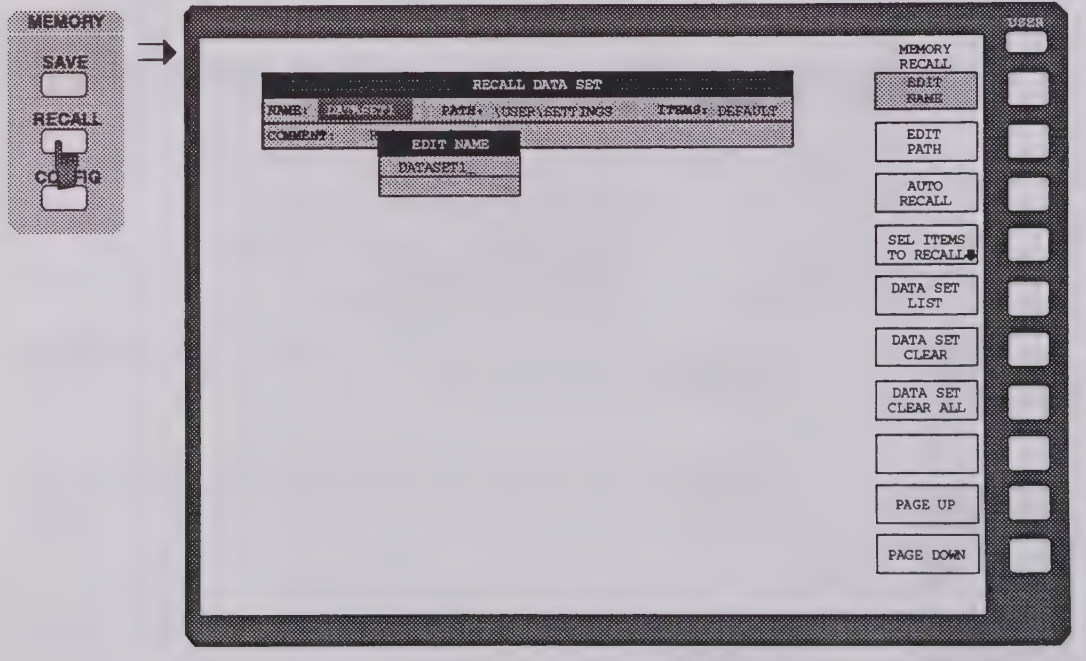
The *RECALL* key activates a menu which contains all functions necessary for recalling data sets.

- Entry of the name of the data set which should be recalled. Confirmation of the entry initiates a load operation to recall the data set.
- Entry of the directory in which the data set is stored
- Display of data set description
- Selection of a data set which will be automatically loaded upon power-up
- Indication of all available data sets
- Deletion of all available data sets
- Selection of the partial data sets which should be loaded (configurations, measurement and calibration data, sub-menu SEL ITEMS TO RECALL)

Any settings not restored when partial data sets are loaded will remain unchanged in the instrument. During recall operations, the FSE recognises which partial data sets are present in the recalled data set and offers only the corresponding settings for selection in the *SELECT ITEM* sub-menu.

A new instrument data set can be easily constructed from several existing data sets: the desired partial data sets are selected and recalled out of various data sets in several *RECALL* operations. When the desired configuration is completed, the new data set can be saved under a new name.

MEMORY RECALL menu:



The *RECALL DATA SET* table shows the current settings regarding the data set:

Name	name of data set
Path	directory in which the data set is located
Items	indicates whether the default selection of the partial data set (DEFAULT) or a user-defined selection (SELECTED) will be loaded
Comment	commentary regarding the data set

The *EDIT NAME* soft key for entering the name of the data set to be loaded is activated automatically.

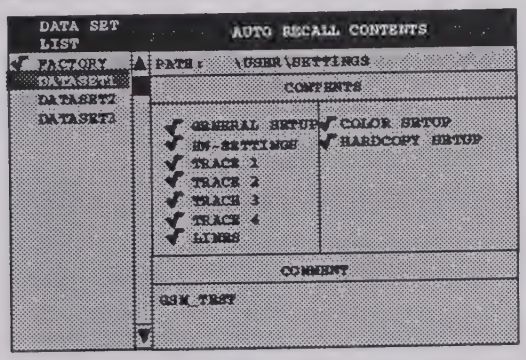
2.7.3.1 Selecting the Data Set for Recalling

MEMORY RECALL menu:

The *EDIT NAME* soft key activates the entry of a data set name.
The data input is terminated by pressing one of the units keys which simultaneously initiates the data set recall operation.

The *EDIT PATH* soft key activates the entry of a directory name in which the data set is located.

The *AUTO RECALL* soft key activates the selection of a data set which is automatically loaded when the instrument is powered on. To this end the table *DATA SET LIST/CONTENT* is opened (analog to *DATA SET LIST).*



The *DATA SET LIST* column displays all data sets present in the selected directory.

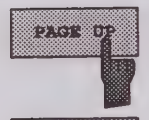
The *CONTENTS* and *COMMENT* lines in the *AUTO RECALL CONTENTS* column indicate the saved partial data sets and the commentary for the currently selected data set.
In addition to the data sets stored by the user, the data set *FACTORY*, which specifies the settings of the instrument before it was last switched off (Standby), is always present.

If a data set other than *FACTORY* is chosen then, at the time of instrument power on, the available partial data sets of the selected data set are recalled. The partial data sets which are not present in this data set are taken from the *FACTORY* data set.

see Chapter "Saving Data Sets"

see Chapter "Saving Data Sets"

see Chapter "Saving Data Sets"

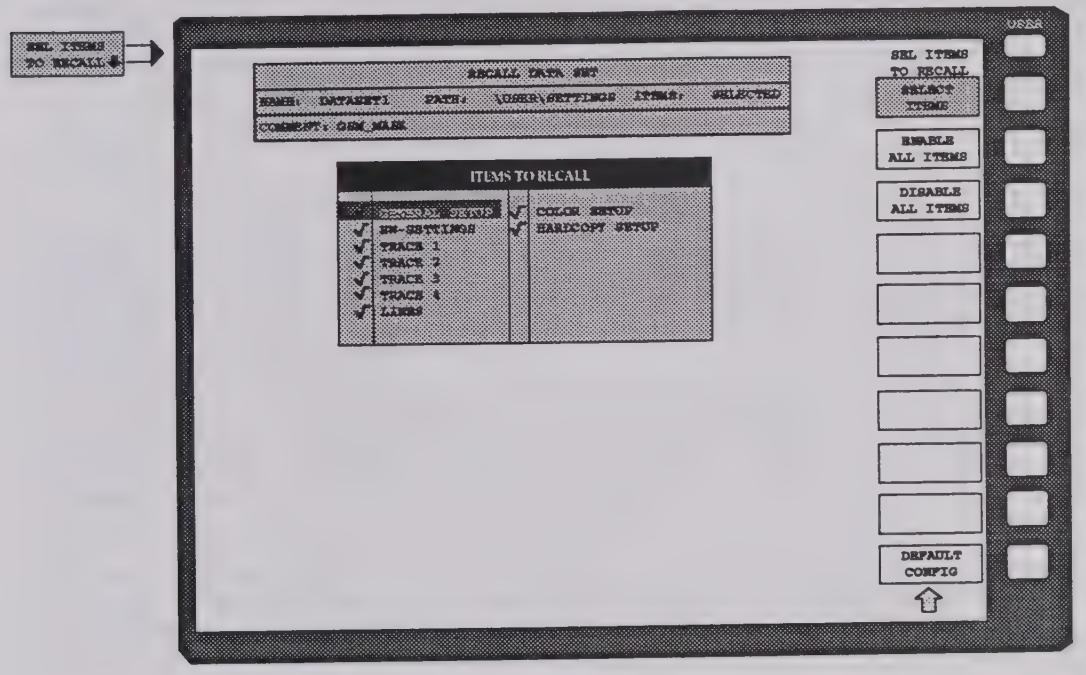


The *PAGE UP* or *PAGE DOWN* soft key sets the *DATA SET LIST* table to the next or previous page.

2.7.3.2 Building a Data Set

The *SEL ITEMS TO RECALL* soft key opens a sub-menu to select partial data sets.

MEMORY RECALL-SELECT ITEMS TO RECALL sub-menu:



The *ITEMS TO RECALL* table displays the selectable partial data sets:

General Setup	current configuration of general instrument parameters
HW-Settings	current measurement hardware settings
Trace1...4	measurement data trace 1 to trace 4
Lines	data point tables for the active limit lines
Color Setup	user-defined color settings
Hardcopy Setup	configuration for hardcopy output

The *SELECT ITEMS* soft key activates the *ITEMS TO RECALL* table and sets the selection bar to the first line, left column of the table.

The *ENABLE ALL ITEMS* soft key marks all entries in the *ITEMS TO RECALL* table.

The *DISABLE ALL ITEMS* soft key unmarks all entries in the *ITEMS TO RECALL* table.

The *DEFAULT CONFIG* soft key establishes the default selection of the partial data set to be recalled and outputs *DEFAULT* in the *ITEMS* field of the *RECALL DATA SET* table.

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2.8 Macros – *USER Key*

The FSE menus are so designed that the analyzer can be easily applied to most of the usual measurement tasks with a minimum number of key operations. However, the *USER* menu also permits a tailored adaptation of any necessary setup and measurement functions needed for special applications. Here, a sequence of key operations, which may occur repeatedly, can be listed in the *USER* menu as a key macro, then stored in memory and recalled as required by the application.

2.8.1 Fundamentals

Macros are defined as arbitrary key sequences which need to be defined only once and then can be recalled as often as desired. Through the use of macros, often-needed measurement functions or instrument setups, which may require a large number of key operations, can be easily performed. The writing of macros is possible only under manual control. Macro generation is not possible under remote control (e.g. via the IEC Bus interface).

A total of 7 different macros can be programmed and assigned to the individual soft keys of the *USER* menu. Each macro has a title (arbitrarily defined by the user) which is also used as a label for the corresponding soft key. To indicate that a macro has not yet been programmed, the soft-key label appears in parenthesis (e.g. (MACRO 1)). After a key-sequence macro has been defined, the parenthesis are removed and the softkey is replaced by the titel specified by the user.

A macro is executed by pressing the corresponding soft key.

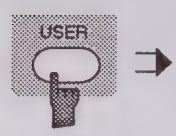
During execution of macros, the key actions are repeated in exactly the **same sequence** as they were programmed. The sequential execution of a macro may be interrupted by using the PAUSE instruction. As soon as a macro is interrupted, adjustments on the Unit Under Test (UUT) may be made, etc. The interrupted macro is allowed to continue by pressing *CONTINUE* in the message window and is aborted by pressing ABORT.

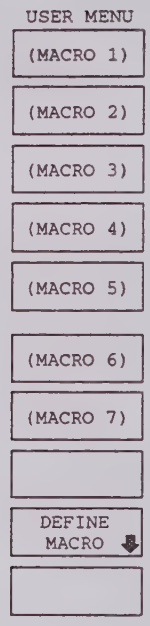
A running macro can be aborted by pressing the *LOCAL* key. At this time, the following message is displayed:

During the time a macro is executing, manual operations on the instrument are not possible, and the soft-key panel is disabled. After interruption or conclusion of a macro, the applicable soft-key panel is enabled (i.e., menu state at the conclusion of the macro).

2.8.2 Starting Macros

USER menu





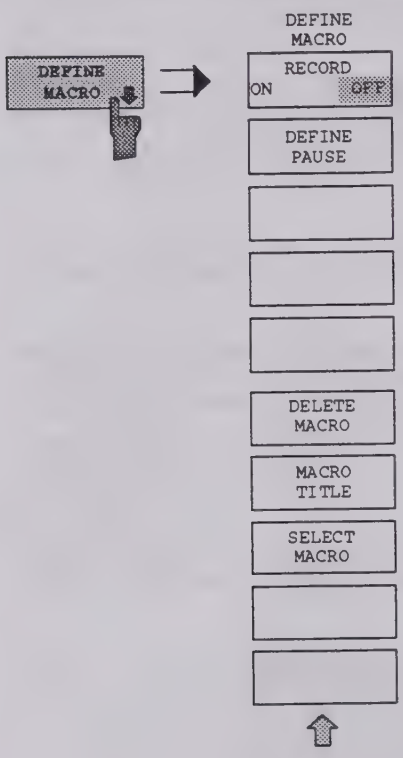
The USER key opens a menu for selection and starting of macros. The macros can be defined in the *DEFINE MACRO* submenu.

The *MACRO 1* to *7* soft keys start the execution of the macros.

2.8.3 Defining Macros

In the *DEFINE MACRO* menu, all necessary soft keys needed for macro management are available. Included are functions for starting and ending macro programming, editing of a macro title, etc.

USER DEFINE MACRO menu



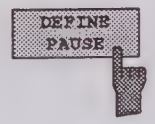
The *DEFINE MACRO* soft key calls the sub-menu to define the macros.
The *SELECT MACRO* soft key is active and opens the box to select the macro to be edited. In case no selection is made, *MACRO 1* is automatically selected.

The *RECORD ON/OFF* starts or stops the recording of the macro.

ON All key actions are recorded until the soft key is changed to *OFF* . To indicate that macro record is enabled, the enhancement label MAC is displayed.

The number of actions which can be stored in a macro is limited. If the limit is exceeded, the error message "Macro too long. Recording aborted" is output and the recording operation is aborted, however, the actions already recorded do remain stored.

OFF The recording is stopped. The key actions are stored under the macro chosen by the *SELECT MACRO* soft key.



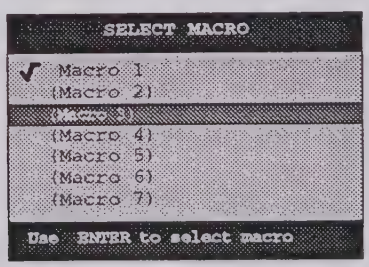
The *DEFINE PAUSE* soft key inserts a pause instruction into the macro sequence which is being recorded. A running macro will pause when it reaches this instruction, at which point settings on the unit under test could for example be made. *CONTINUE* in the message window is used to continue the macro execution.

The *DELETE MACRO* soft key deletes the macro which was previously selected by the *SELECT MACRO* soft key. The soft key of the deleted title now carries its default label (*MACRO X*, X = macro number)

The *MACRO TITLE* soft key activates the entry of the title for the selected macro .

Because the macro title is used for labelling the corresponding soft key, a maximum of only 20 characters is allowed. All text after the 10 th character is written to the second line. However, entering the character @ forces a new line at any point in the soft key title.

The *SELECT MACRO* soft key open the selection box with a list of all 7 macros. All soft-key functions of this menu are related to this macro.



2.9 Analyzer Mode

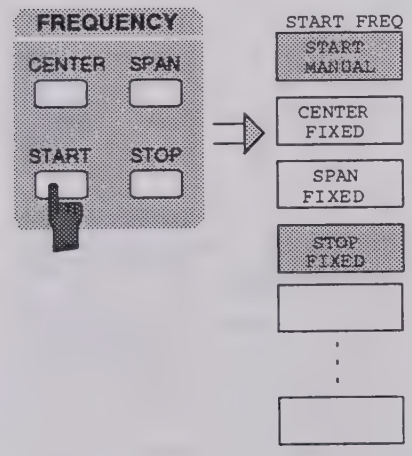
2.9.1 Frequency and Span Selection – *FREQUENCY Key Group*

The *FREQUENCY* key group is used to specify the frequency axis of the active measurement window. The frequency axis can be defined either by the start and stop frequency or by the center frequency and span. For the case when two measurement windows (*SPLIT-SCREEN)* are displayed simultaneously, data entered are always related to the window selected in the *SYSTEM-DISPLAY* menu.

After pressing one of the keys *CENTER*, *SPAN*, *START* or *STOP*, the value of the corresponding parameter can be defined in the appropriate dialog window. At the same time, a soft key menu appears, which allows selecting the optional parameters.

2.9.1.1 Start Frequency – *START Key*

FREQUENCY – START menu:



The *START* key opens a menu which displays the various options for setting the start frequency of the sweep. The *START MANUAL* soft key is automatically active and opens the entry window for manual input of the start frequency. At the same time, the coupling of the parameters is set to *STOP FIXED*

The *STOP FIXED, SPAN FIXED* and *CENTER FIXED* soft keys are mutually exclusive selection switches. Only one of these switches may be active at any one time. The frequency coupling selected by the soft keys defines which of the dependent parameters stop frequency, center frequency and span is to remain constant when a change in the start frequency is made.

The *START MANUAL* soft key activates manual entry of the start frequency.

The allowed range of values for the start frequency is:

$0\ Hz <= f_{start} <= f_{max} - minspan/2$

f_{start} start frequency

minspan smallest selectable span)

f_{max} model-dependent max. frequency

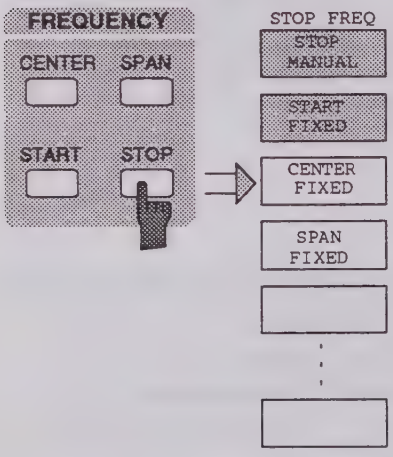
If the *STOP FIXED* key is active, the stop frequency remains constant when the start frequency is changed. The center frequency is adjusted to the new frequency range. *STOP FIXED* coupling is the default setting.

If the *SPAN FIXED* soft key is active, the span remains constant when the start frequency is changed. The stop frequency is adjusted to the new frequency range.

If the *CENTER FIXED* soft key is active, the center frequency remains constant when the start frequency is changed. The stop frequency is adjusted to the new frequency range.

2.9.1.2 Stop Frequency – *STOP Key*

FREQUENCY – STOP menu:



The *STOP* key opens a menu which displays the various options for setting the stop frequency of the sweep .

The *STOP MANUAL* soft key is automatically active and opens the entry window for manual input of the stop frequency. At the same time, parameter coupling is set to *START FIXED*.

The *START FIXED, CENTER FIXED* and *SPAN FIXED* soft keys are mutually exclusive selection switches. Only one switch can be active at any one time. The soft keys are used to select the frequency coupling. The frequency coupling defines which of the dependent parameters start frequency, center frequency or span is to remain constant when the stop frequency is changed.

The *STOP MANUAL* soft key activates the manual entry window for the stop frequency.

The allowed range of values for the stop frequency is:

$minspan <= f_{stop} <= f_{max}$

f_{stop}	stop frequency
minspan	smallest selectable span (10Hz)
f_{max}	model-dependent max. frequency

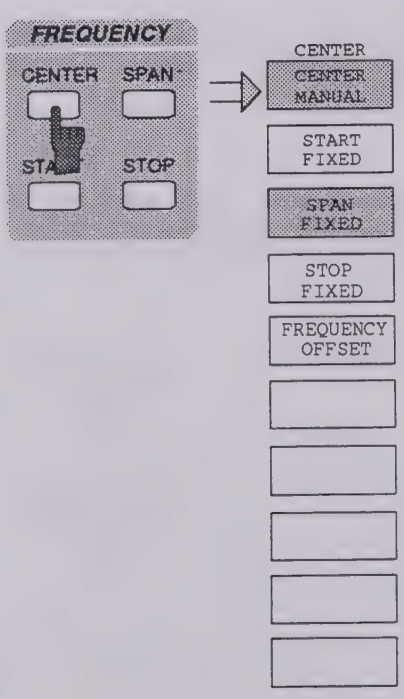
If the *START FIXED* soft key is active, the start frequency remains constant when the stop frequency is changed. The center frequency is adjusted to the new frequency range. The *START FIXED* coupling is the default setting.

If the *CENTER FIXED* soft key is active, the center frequency remains constant when the stop frequency is changed. The start frequency is adjusted to the new frequency range.

If the *SPAN FIXED* soft key is active, the span remains constant when the stop frequency is changed. The start frequency is adjusted to the new frequency range.

2.9.1.3 Center Frequency – *CENTER Key*

FREQUENCY – CENTER menu:



The *CENTER* soft key opens a menu which displays the various options for setting the center frequency of the sweep.

The *CENTER MANUAL* soft key is automatically active and opens the entry window for manual input of the center frequency. At the same time, the coupling of the parameters is set to *SPAN FIXED*.

The *START FIXED*, *STOP FIXED* and *SPAN FIXED* soft keys are mutually exclusive selection switches. Only one switch can be active at any one time. The soft keys are used to select the frequency coupling. The frequency coupling defines which of the dependent parameters start frequency, stop frequency or span remains constant when the center frequency is changed.

The *CENTER MANUAL* soft key activates the manual entry window for entering the center frequency.

The allowed range of values for the center frequency is:

for the frequency domain (span > 0):

$0\ Hz <= f_{center} <= f_{max} - minspan/2$

and for the time domain (span = 0)

$0\ Hz <= f_{center} <= f_{max}$

f_{center}	center frequency
minspan	smallest selectable span (10Hz)
f_{max}	model-dependent max. frequency

If the *SPAN FIXED* soft key is active, the span remains constant when the center frequency is changed. The start and stop frequency are adjusted to the new frequency range. *SPAN FIXED* coupling is the default setting.

If the *START FIXED* soft key is active, the start frequency remains constant when the center frequency is changed. The span is adjusted to the new frequency range.

If the *STOP FIXED* soft key is active, the stop frequency remains constant when the center frequency is changed. The span is adjusted to the new frequency range.

The *FREQUENCY OFFSET* soft key activates the entry window for an arithmetical frequency offset which is added to the frequency axis labelling. The allowable range of input values is 0 Hz to 100 GHz. The default setting is 0 Hz.

2.9.1.4 Center Frequency Step Size

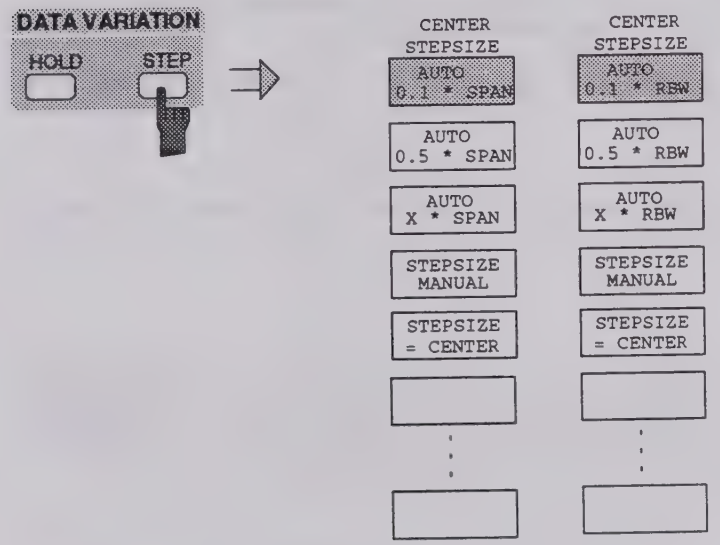
The *STEP* key in the *DATA VARIATION* key group opens a menu for setting the step size of the center frequency. The step size can be coupled to the span (frequency domain) or the resolution bandwidth (time domain) or it can be manually set to a fixed value.

In order to change the step size, the entry window for the center frequency must already be active. After pressing the *STEP* key, the *CENTER STEP* menu appears. The soft keys are presented according to the selected domain (frequency or time).

The soft keys are mutually exclusive selection switches. Only one switch can be active at any one time.

Control is returned to the *FREQUENCY CENTER* menu via the menu key.

DATA VARIATION - STEP menu for span ≠ 0 for span = 0



Frequency domain: The *AUTO 0.1 * SPAN* soft key sets the step size of the center frequency entry to 10% of the span.

Time domain: The *AUTO 0.1 * RBW* soft key sets the step size of the center frequency entry to 10% of the resolution bandwidth

*AUTO 0.1 * RBW* is the default setting.

Frequency domain: The *AUTO 0.5 * SPAN* soft key sets the step size of the center frequency entry to 50% of the span.

Time domain: The *AUTO 0.5 * RBW* soft key sets the step size of the center frequency entry to 50% of the resolution bandwidth

Frequency domain: The *AUTO X * SPAN* soft key activates the entry of the factor defining the center frequency step size as a % of span.

Time domain: The *AUTO X * RBW* soft key activates the entry of the factor defining the center frequency step size as a % of the resolution bandwidth.

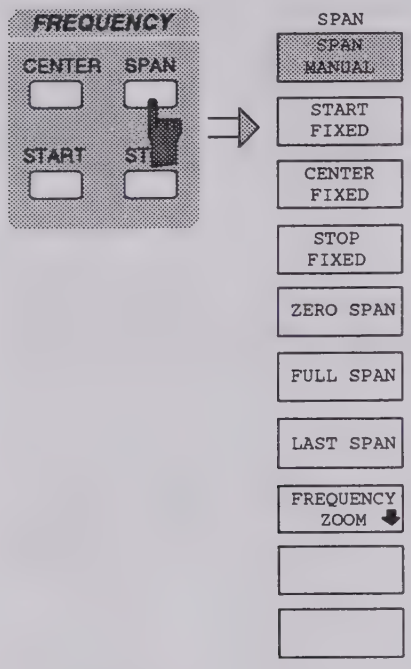
Values between 1 and 100% in steps of 1% are acceptable. The default setting is 10%.

The *STEPSIZE MANUAL* soft key activates the entry window for the input of a fixed step size.

The *STEPSIZE = CENTER* soft key sets the step size coupling to *MANUAL* and the step size to a value equal to the center frequency. This function is especially useful during measurements of the signal harmonic content, because, when entering the center frequency, the center frequency of another harmonic is selected with each stroke of the *STEP* key.

2.9.1.5 Frequency Span – *SPAN Key*

FREQUENCY – SPAN menu:



The *SPAN* key opens a menu which displays various options for the selection of sweep span.

The *SPAN MANUAL* soft key is automatically active and opens the entry window for manual input of the span. At the same time, the parameter coupling is set to *CENTER FIXED.*

The *START FIXED, CENTER FIXED* and *STOP FIXED* soft keys are mutually exclusive selection switches. Only one switch can be active at any one time. The frequency coupling is selected with these soft keys. The frequency coupling defines which of the dependent parameters start frequency, center frequency or stop frequency is to remain constant when the span is changed

The *SPAN MANUAL* soft key activates the manual entry of the span.

The allowed range of input values for span are:
time domain (span = 0):

0 Hz

frequency domain (span > 0):

$minspan <= f_{span} <= f_{max}$

f_{span}	frequency span
minspan	smallest selectable span (10Hz)
f_{max}	model-dependent max. frequency

The *ZERO SPAN* soft key sets the span value to 0 Hz. The x axis becomes the time axis. The axis labelling corresponds to the sweep time (on the left, 0 ms, on the right, the current sweep time (SWT)).

The *FULL SPAN* soft key sets the span value to the maximum span of the FSE.

The *LAST SPAN* soft key switches the instrument between a detailed measurement (given: center frequency and span) mode and an overview measurement (*FULL SPAN*) mode.

The *FULL SPAN* soft key modifies the center frequency as well as the selected span. The *LAST SPAN* soft key cancels this change.

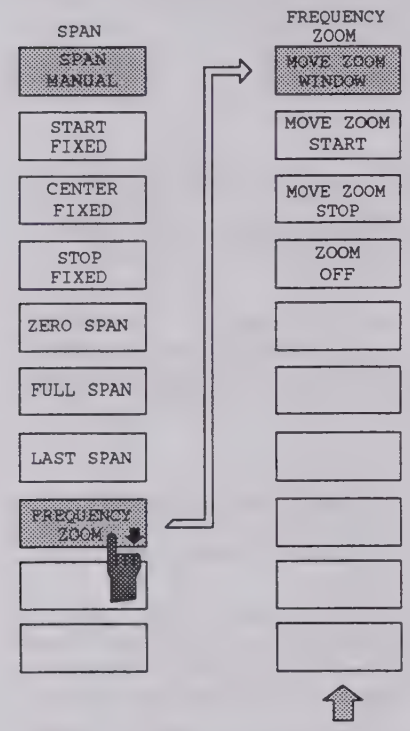
If the *START FIXED* soft key is activated, the start frequency remains constant when the span is changed. The center and stop frequency are adjusted to the new span.

If the *CENTER FIXED* soft key is activated, the center frequency remains constant when the span is changed. The center and stop frequency are adjusted to the new span. The *CENTER FIXED* coupling is the default setting.

If the *STOP FIXED* soft key is activated, the stop frequency remains constant when the span is changed. The center and start frequency are adjusted to the new span.

2.9.1.6 Display Zoom

FREQUENCY SPAN-FREQUENCY ZOOM submenu:



The *FREQUENCY ZOOM* soft key activates the zoom mode and opens a sub-menu to define the zoom span.

Two frequency lines, which show and define the frequency range to be zoomed, appear in the active measurement window when the zoom mode is switched on. The default setting is a zoom span of 10% to the left and 10% to the right of the center frequency. The zoomed display is shown in the second measurement window.
The settings for the second measurement window are taken from the original window. The second measurement window thus becomes the active measurement window and its settings can now be changed.

If only one window is active when the zoom function is selected, *SPLIT SCREEN* mode is automatically switched on.

The zoom span can be edited by using the soft keys of the sub-menu to change the position of the frequency lines.

When the zoom mode is switched off, *SPLIT SCREEN* mode remains active, the settings of both measurement windows are retained and the coupling of the two measurement windows is cancelled.

The *MOVE ZOOM WINDOW* soft key assigns the roll-key/left, right cursor key to the full zoom window.
The window can shifted until the upper frequency line has reached the stop frequency or the lower frequency line has reached the start frequency of the original window.

The *MOVE ZOOM START* soft key assigns the roll-key/left, right cursor key to the lower frequency line. Thus, the start frequency of the zoomed display can be modified. The frequency line can be shifted down to the start frequency of the original window or up to the upper frequency line (= zero span).

The *MOVE ZOOM STOP* soft key assigns the roll-key/left, right cursor key to the lower frequency line. Thus, the stop frequency of the zoomed display can be modified. The frequency line can be shifted up to the stop frequency of the original window or down to the lower frequency line (= zero span).

The *ZOOM OFF* soft key switches the zoom function off and then returns control to the main menu. The frequency lines for indicating the zoom range are deleted.

2.9.2 Level Display and RF Input Configuration – *LEVEL Key Group*

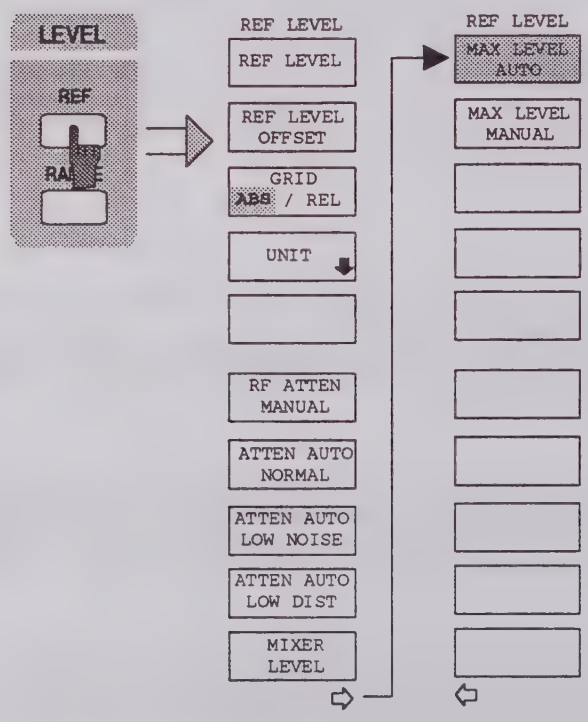
The *REF* and *RANGE* keys are used to set the reference level (= maximum RF input level, = overload limit), the maximum level (= upper grid level) , and the display range of the active window. The *INPUT* key sets the characteristics of the RF input (input impedance and input attenuation).

2.9.2.1 Reference Level – *REF* key

In addition to the reference level (maximum RF input level), the FSE provides a function to define a maximum level (uppermost grid line on the display):
For a spectrum analyzer, the upper boundary of the measurement diagram (maximum level) is also the limit of its dynamic range (reference level). This means, that a signal which goes beyond the upper grid line also overdrives the analyzer.

For compensation of frequency or antenna characteristics, transducer factors can be applied to increase the signal level. In this case, the calculated values can be above the reference level without actually being physically applied to the instrument. In order to display these signals on the grid, an upper grid level which is different from the reference level of the analyzer can be entered.

LEVEL REF menu:



The *REF* key opens a menu to set the reference level and the input attenuation for the active measurement window .

The *REF LEVEL* soft key is automatically active with the menu called up and opens the entry window for manual input of the reference level.

At the same time various settings concerning the level and the attenuation display can be made.

The functions for setting the attenuation are identical to those under the *INPUT* key and are described in Section 2.9.2.4.

The *REF LEVEL* soft key activates the entry of the reference level. The input is made in the currently active units (dBm, dBµV, etc.).

If the *MAX LEVEL MANUAL* softkey is active, a change of the reference level causes an equal amount of change in maximum level Thus, the separation between the overload limit of the analyzer to the upper grid edge remains the same. Thus, with only one entry, it is possible to make a change to the display and simultaneously to perform an adjustment to the amplifier.

The *REF LEVEL OFFSET* soft key activates the entry of an arithmetic offset (±200 dB in 0,1 dB steps) to the level. The offset is added to the measured level dependent upon the selected units. The scaling of the y axis is changed accordingly.

The *GRID ABS/REL* soft key switches between absolute and relative scaling of the level axis. *GRID ABS* is the default setting.

For absolute scaling the labelling of the level lines is referenced to the absolute value of the reference level.

For relative scaling, the upper line of the grid is always at 0 dB and the scale units are in dB. In contrast, the reference level is always displayed in the set units (dBm, dBµV,..).

The soft key is not displayed for setting *LIN / %* (linear scaling, labelling in %) in the *LEVEL-RANGE* menu since the % unit itself implies a relative scale.

The *MAX LEVEL MANUAL* and *MAX LEVEL AUTO* soft keys are mutually exclusive selection switches. Only one switch can be active at one time. The soft keys are used to select whether reference level and maximum level are identical or not:

When *MAX LEVEL AUTO* soft key is active, the reference level and maximum level are identical.
In this case, the reference level is displayed above the upper left corner of the grid in the corresponding function field.

MAX LEVEL AUTO is the default setting.

If the *MAX LEVEL MANUAL* soft key was active prior to pressing the *MAX LEVEL AUTO* soft key, the upper boundary of the grid is set to the reference level.

The *MAX LEVEL MANUAL* soft key activates the entry of the maximum level. The range of input values is ± 200dBm with 0.1 dB resolution.

If the *MAX LEVEL MANUAL* soft key is activated, the maximum level is displayed in addition to the reference level to the right above the grid.

2.9.2.2 Display Units

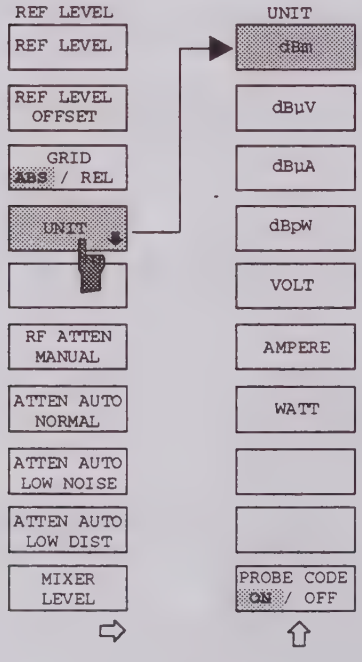
In general, a spectrum analyzer measures the signal voltage at the RF input. The level display is calibrated in rms values of an unmodulated sine wave signal. In the initial state, the level is displayed at a power of 1 milliwatt (= dBm). Via the known input resistance of 50Ω, a conversion can be made to other units. The units dBm, dBµV, dBµA, dBpW, V, A and W are directly convertible and can be selected in the *REF UNIT* menu.

If the antenna coded connector on the front panel is used, the coded unit there determines the possible display units. Connecting to the coded connector deactivates the settings of the *UNIT* menu.
By certain codings it is nevertheless possible to select a conversion of the unit in the menu. The dependencies between the unit of the antenna coded connector and the unit which is to be selected for the display are given in the soft key description.

The default coding defined by the connector can be switched off using the *PROBE CODE ON/OFF* soft key. In this case, the unit can be set with the corresponding unit soft keys (dBm, dBµV, ...) even if a coded connector is plugged in. The coded entries in the connector are then ignored.

Note: *The units dBµV/m and dBµA/m can only be set via the unit of the coded connector.*

LEVEL REF UNIT submenu:



The *UNIT* soft key opens a sub-menu in which the desired units for the level axis can be selected and the coding of the antenna coded connector can be switched on and off.

The selected units are valid for both displays when two measurement windows are displayed.

The unit soft keys are mutually exclusive selection switches. Only one of these switches may be active at any one time.

The *dBm, dBµV, dBµA, dBpW* soft keys set the display units to the corresponding logarithmic units. The dBm unit is the default unit in analyzer mode.

The units *dBm, dBµV, dBµA* cannot be selected when the coded antenna connector defines one of the following as units:

dBµV/m
dBµA/m

For codings dB, dBµV and dBµA, the conversion to the desired units is permitted.

The *VOLT, AMPERE, WATT* soft keys set the display units to the corresponding linear units.

The units *VOLT, AMPERE, WATT* cannot be selected when the coded antenna connector defines one of the following as units:

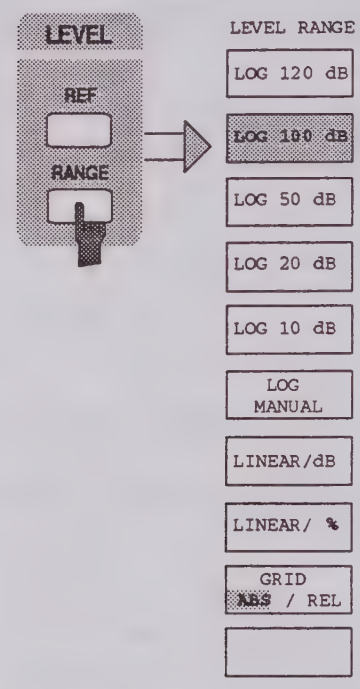
dBµV/m
dBµA/m

For codings dB, dBµV, dBµA and dBpW, the conversion to the desired units is permitted.

The *PROBE CODE ON/OFF* soft key enables or disables the units defined by the coded connector.

2.9.2.3 Level Range – *RANGE* Key

LEVEL RANGE menu:



The *RANGE* key calls a menu in which the range, linear or logarithmic the display scale, absolute or relative and the level units for the active window can be selected.

The display range of the analyzer can be set in 10 dB steps from 10 to 200 dB. The default setting is 100 dB.

The most often used settings (120 dB, 100 dB, 50 dB, 20 dB and 10 dB) are each directly selectable by a soft key.
All other ranges are chosen with the *LOG MANUAL* soft key.

After pressing the *RANGE* key, the *LOG MANUAL* entry window is enabled if the display range is not set to *LIN.*

The *LOG MANUAL* soft key activates the entry of the level display range. Display ranges from 10 to 200 dB are allowed in 10-dB steps. Values which are not permissible are rounded to the next valid number.

The *LINEAR/dB* soft key switches the display range of the analyzer to linear scaling. The horizontal lines are labelled according to the selection *GRID ABS/REL* in dB* or *.

The *LINEAR/%* soft key switches the display range of the analyzer to linear scaling. The horizontal lines are labelled in %. The grid is divided into decades.

The *GRID ABS/REL* soft key switches between absolute and relative scaling of the level axis. *GRID ABS* is the default setting.

ABS The labelling of the level lines is referenced to the absolute value of the reference level.

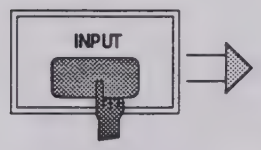
REL The upper line of the grid is always at 0 dB and the scale units are in dB. In contrast, the reference level is always displayed in the set units (dBm, dBµV,..).

The soft key is not displayed for setting *LIN / %* (linear scaling, labelling in %) since the % unit itself implies a relative scale.

2.9.2.4 RF Input Configuration – *INPUT* Key

In addition to manual entry of the input attenuation, the FSE provides an option which allows the RF attenuation, dependent on the selected reference level, to be automatically set. Thus, it is guaranteed that an optimum combination of RF attenuation and IF amplification is always used. For the automatic selection process, three modes are provided. The *AUTO LOW NOISE* mode selects the amplification/attenuation combination so that the display of noise on the FSE is at a minimum. The signal/noise ratio is maximised. The *AUTO LOW DISTORTION* mode is tuned for minimisation of the internally generated interference products. This causes, however, a lower signal/noise ratio. The *ATTEN AUTO NORMAL* mode is a compromise between low noise and low distortion.

INPUT menu:



The *INPUT* key opens the menu for configuring the RF input. It contains the input attenuator and mixer level for matching the RF input to the input signal.

The *RF ATTEN MANUAL*, *ATTEN AUTO NORMAL*, *ATTEN AUTO LOW NOISE* and *ATTEN AUTO LOW* soft keys are mutually exclusive selection switches. only one can be active at any one time.

The *INPUT SELECT* soft key calls a submenu for selection of the input impedance.

The *RF ATTEN MANUAL* soft key activates the entry of an attenuation factor independent of the reference level.

The attenuation can be set in 10 dB steps between 0 and 70 dB.
Other inputs will be rounded to the next lower integer value.

If the defined reference level cannot be set for the given RF attenuation, the reference level will be adjusted accordingly and the warning "Level Limit reached" will be output.

The *ATTEN AUTO NORMAL* soft key sets the RF attenuation automatically independent of the selected reference level.

The *ATTEN AUTO LOW NOISE* soft key sets the RF attenuation always 10dB lower than in the *RF ATTEN AUTO* mode. Therefore, for 10 dB RF attenuation, the maximum reference level is -10 dBm. For reference levels which are lower, at least 10 dB is always set (see above).

Setting Low Noise means that the indicated inherent noise level is low. This setting is recommended if signals with a low level have to be measured as the highest S/N ratio is then obtained.

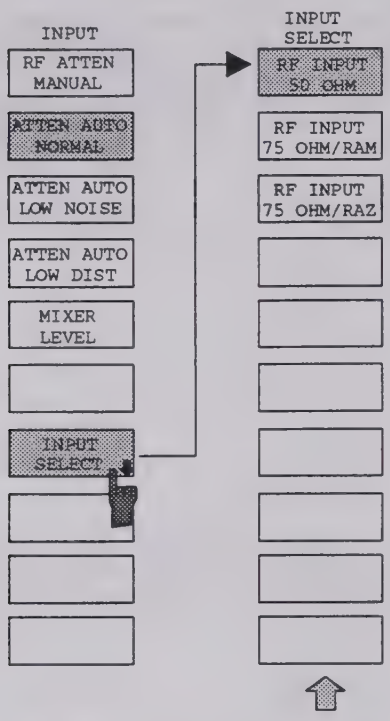
The *ATTEN AUTO LOW DIST* soft key sets the RF attenuation 10 dB higher than in *RF ATT AUTO* mode. This means that for 10 dB RF attenuation, the maximum reference level is -30 dBm (-40 dBm at the mixer).

This setting is recommended whenever a small signal is to be measured in the presence of larger signals. Here, the intermodulation-free range of the FSE is large and the internal distortion products are minimised.

The *MIXER LEVEL* soft key activates the entry of the maximum mixer level attainable for a given reference level. At the same time it enables soft keys *ATTEN AUTO LOW NOISE* and *ATTEN AUTO LOW DIST* .

Range of input values is -10 to -80 dBm

INPUT INPUT SELECT submenu:



The *INPUT SELECT* soft key calls a submenu for selection of the input impedance of the RF input.

The basic setting is 50 Ohm. By connecting an impedance converter RAM or RAZ ahead, the 50-Ohm input can be transformed to 75 Ohm. FSE automatically takes the corresponding correction values for the level display into account.

The soft keys used to select the input impedance are selection switches. Only one of them can be active at any one time

The *RF INPUT 50 OHM* soft key sets the input impedance to 50 Ω (= default setting). All level indications are referenced to 50 Ω.

The *RF INPUT 75 OHM/RAM* soft key sets the input impedance of the FSE to 75 Ω including the matching element RAM. All level indications are referenced to 75 Ω.

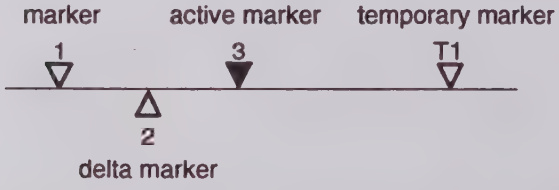
The *RF INPUT 75 OHM/RAZ* soft key sets the input impedance of the FSE to 75 Ω including the matching element RAZ. All level indications are referenced to 75 Ω.

2.9.3 Marker Functions – *MARKER Key Group*

The markers are used for marking points on measurement curves, reading out measurement values and for quickly selecting a display screen segment. Preselected measurement routines can be called by pressing a key in the marker menu. The FSE provides four markers and four delta markers per measurement window. The currently activated marker can be shifted with the cursor keys, the roll-key or the soft keys. The soft keys are defined according to the type of display representation selected (frequency or time domain)..

The marker which can be moved by the user is defined as the **active marker**.

Examples:

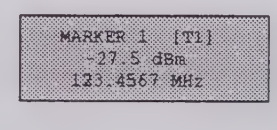


The measurement values of the active marker (also called **marker values**) are displayed in the marker field. In the **marker info list**, the measurement values from all enabled markers are sorted in ascending order. The marker info list can be switched off with the *MARKER INFO* soft key so that only the values for the active marker are shown.

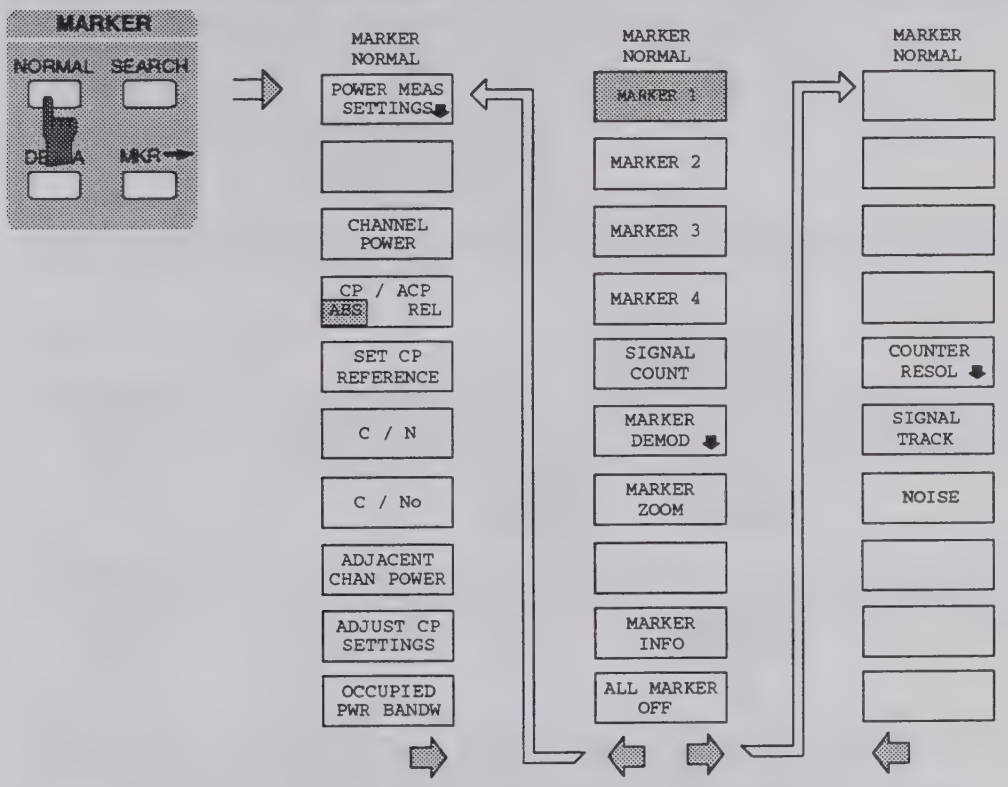
2.9.3.1 Main Markers– *NORMAL Key*

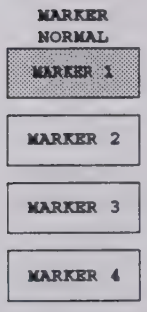
The *NORMAL* key calls a menu which contains all standard functions. The current state of the markers is indicated by a colored illumination of the soft keys. If no marker is enabled prior to pressing the *NORMAL* key, *MARKER 1* will be enabled as the reference marker and a peak search on the measurement curve is carried out (assumption: at least one measurement curve is active). Otherwise, the peak search is omitted and the entry window for the reference marker is activated.

The marker field at the upper left of the display screen shows the marker location (here, frequency), the level and the currently selected measurement curve.



MARKER NORMAL menu:

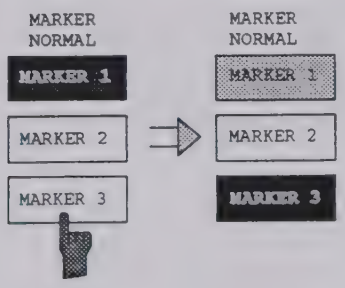




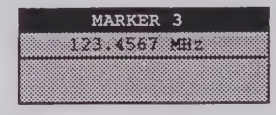
The *MARKER 1* to *MARKER 4* soft keys switch the corresponding marker on/off or activate it as the reference marker. If the marker is activated as a reference marker, an entry field for manually setting the position of the reference marker is opened simultaneously. If the marker is disabled, the soft key is not illuminated. Enabled markers and the reference marker are indicated by illuminating the corresponding soft keys in different colors.(In the instrument default state, the active reference marker is displayed in red and enabled markers are displayed in green.)

Operating example:

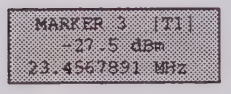
MARKER 1 is shown as the reference marker by the colored background illumination. *MARKER 2* through *MARKER 4* are turned off.

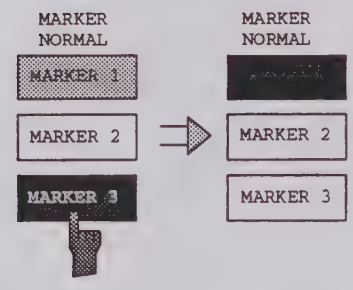


Pressing the *MARKER 3* soft key switches *MARKER 3* on and it becomes the reference maker. The previous reference marker remains enabled and the soft key remains illuminated. However, the entry mode for this marker is not now active. Instead, the entry window for *MARKER 3* is opened and the position of *MARKER 3* can be shifted.



The information in the marker field also changes to describe the new reference marker.





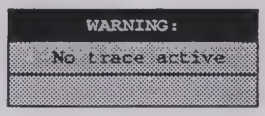
Pressing the current reference marker (*MARKER 3)* soft key again switches *MARKER 3* off. If at least one marker is enabled, the marker with the smallest number will be selected as the new reference marker (in the example, *MARKER 1*). Switching off the last active marker also deletes are delta markers.

When several measurement curves (traces) are being displayed, the marker is set to the maximum value (peak) of the active curve which has the lowest number (1 to 4). In case a marker is already located there, it will be set to the frequency of the next highest level (next peak).

When the split screen display mode is active, the marker will be placed in the active window (for *SCREEN A*: trace 1 or 3, for *SCREEN B*: trace 2 or 4). Since markers are attached to a measurement curve, the marker can only be enabled when at least one curve in the corresponding window is visible .

If a measurement curve is turned off, the corresponding markers and marker functions are also erased. If the curve is switched on again (*VIEW, CLR/WRITE*;..), these markers along with coupled functions will be restored to their original positions. A prerequisite for the restoration of the marker positions is that individual markers have not been used on another measurement curve or that the sweep data (start/stop frequency for span > 0 or sweep time for span = 0) have not been changed.

If a marker (or, delta marker) necessary for a marker function is not available, it will be automatically checked whether or not the enabling of the corresponding marker is possible (see above). If this is not the case, a warning is issued.



The activation of the desired marker function is then not possible.

On the other hand, if the marker can be enabled, a peak search is automatically performed. Thereafter, the desired marker function can be executed.

MARKER NORMAL menu:

The *ALL MARKER OFF* soft key switches off all markers (reference and delta markers). Similarly, it switches off all functions and displays correlated with the markers/delta markers (signal count, signal track, marker zoom, N dB down, shape factor, marker list and marker info).

After each sweep, the *SIGNAL TRACK* soft key starts a search for the maximum signal level on the display screen (*PEAK SEARCH)* and then sets the center frequency to this signal (*MARKER ->CENTER).*

If a threshold line is enabled, only signals above the threshold level are considered. If no signal is over the threshold, the center frequency remains constant until a signal is available which is over the threshold.

If no marker is switched to the active trace, the next unused marker is automatically activated and positioned by the peak search routine.

In order to reduce the search range, it is possible to apply the *SEARCH LIMIT ON/OFF* function (see section: "Search Functions").

The soft key is only available in the frequency domain (spectrum) display mode (span > 0.)

The *MARKER ZOOM* soft key expands the area around the active marker. With the zoom function, more details of the spectrum can be seen. The desired display range can be defined in an entry window.

The following sweep is stopped at the position of the reference marker. The frequency of the signal is counted and the measured frequency becomes the new center frequency. The zoomed display is then configured and the new settings are used by the FSE for further measurements.

As long as switching to the new frequency display range has not yet taken place, pressing the soft key will abort the procedure.

If no marker is activated when the soft key is pressed, then *MARKER 1* is automatically activated and set to the highest peak in the measurement window.

If an instrument setting is changed after selection of *MARKER ZOOM*, the function is aborted.

The *MARKER ZOOM* soft key is only available in the frequency domain (span > 0).

The *MARKER INFO* soft key opens the display of several markers within the grid. In the upper right corner of the grid, a maximum of 4 markers/delta markers with the marker symbols Δ/∇, marker number (1 to 4), position and measurement value are listed. For the output of the marker position, the number or displayed characters will be limited as required.

If the number of lines available is not enough for all the enabled markers and delta markers, first the markers and then the delta markers are entered into the info list

In the *SPLIT SCREEN* display, the info list is partitioned into 2 partial lists and assigned to the corresponding measurement window (*SCREEN A* and *SCREEN B*). The info list for *SCREEN A* contains the markers which are assigned to trace 1 or trace 3. The info list for *SCREEN B* contains the markers which are assigned to trace 2 and trace 4.

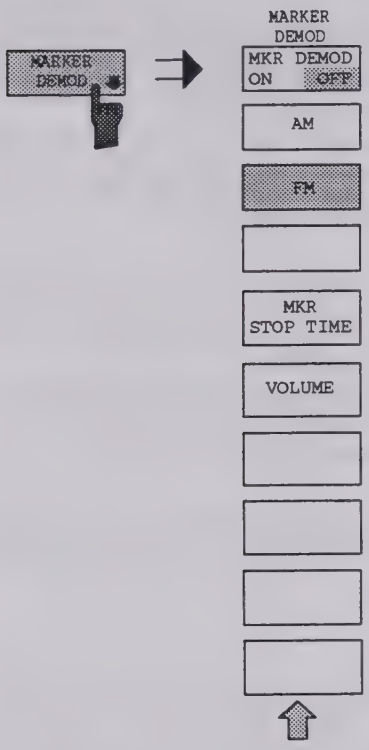
For the two measurement windows, it is not possible to turn the *MARKER INFO* function selectively on/off .

2.9.3.1.1 LF Demodulation

The FSE provides demodulators for AM and FM signals. With these demodulators, a displayed signal can be identified acoustically through the use of the internal loudspeaker or with external headphones. The frequency at which the demodulation is enabled is coupled to the markers. The sweep stops at the frequency determined by the set marker for the selected time and the RF signal is demodulated.

The threshold line performs a squelch function in the demodulator. If the threshold is set, the FSE LF demodulation is switched on only when the signal to be demodulated exceeds the set threshold.

MARKER NORMAL-MARKER DEMOD submenu:



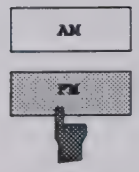
The *MARKER DEMOD* soft key calls a sub-menu in which the type of demodulation desired, the duration of the demodulation and the loudness may be selected

The *MKR DEMOD ON/OFF* soft key switches the demodulation on/off. When the demodulation is on, the sweep is stopped at all marker frequencies, assuming the signal is over the threshold, and the signal is demodulated for the duration of the defined stop time. A total of four stopping points (four markers) can be programmed.

If no marker is set when the demodulation is switched on, the FSE switches the first marker on (*MARKER 1*) and sets it to the largest signal.

The *MKR STOP TIME* soft key activates the entry window for setting the stop time.

The FSE stops the sweep at the marker or the marker for the duration of the defined stop time and then switches the demodulation on (see also *MKR DEMOD ON/OFF*).



The *AM* and *FM* are selection switches of which only one can be activated at any one time. They are used to set the desired demodulation type, FM or AM. The default setting is AM.

The *VOLUME* soft key opens the entry window for setting the loudness. The volume can be set between 0 and 100%.

2.9.3.1.2 Frequency Measurement

In order to perform an exact determination of the frequency of a signal, the FSE is equipped with an internal frequency counter. The frequency counter measures the frequency of the RF signal at the intermediate frequency. Using the value found at the intermediate frequency, the FSE calculates the frequency of the RF signal by applying the known frequency conversion relationships.

The frequency measurement error depends only upon the accuracy of the frequency standard used (external or internal reference). Although the FSE always operates with a synchronous sweep, independent from the set span, the frequency counter delivers a more exact frequency measurement than a measurement performed with a marker. This is explained by the following:

- The marker measures only the position of the pixel on the measurement curve (trace) and infers therefrom the frequency of the signal. The trace, however, contains only a limited number of pixels. Each pixel, depending upon the selected span, may contain many measurement values which, as a consequence, causes a limitation in the frequency resolution.
- The resolution with which the frequency can be measured is proportional to the measurement time. For measurement time reasons, the bandwidth is normally held as wide as possible and the sweep time is set a short as possible. This results in a loss of frequency resolution.

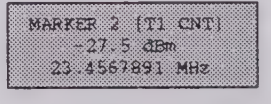
For the measurement with the frequency counter, the sweep is stopped at the reference marker, the frequency is counted with the desired resolution and then the sweep is allowed to continue (see also Chapter 2, section: "Measurement Examples").

MARKER NORMAL menu:

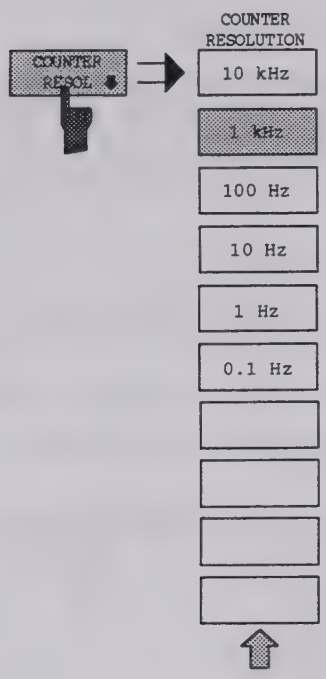
The *SIGNAL COUNT* soft key switches the frequency counter on/off. The frequency is counted at the position of the reference marker. The sweep stops at the reference marker until the frequency counter has delivered a result. The time required for a frequency measurement depends on the selected frequency resolution. The resolution is set in the *COUNTER RESOL* sub-menu.

If no marker is enabled when the *SIGNAL COUNT* soft key is pressed, *MARKER 1* is switched on and set at the largest signal.

In addition, the *SIGNAL COUNT* function is displayed in the marker field on the display screen with [Tx CNT].



Switching the *SIGNAL COUNT* function off is accomplished by pressing the soft key once again.

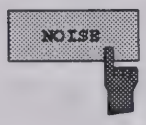


The *COUNTER RESOL* soft key in the right-hand supplementary menu opens a sub-menu in which the resolution of the frequency counter can be defined. The value can be selected between 0.1 Hz and 10 kHz.

The time which the frequency counter requires for a measurement is proportional to the selected resolution. For example, a 1 Hz resolution will require approximately one second measurement time. In order to prevent slowing the sweep time unnecessarily, it is recommended that the frequency resolution be set as low as possible.

2.9.3.1.3 Noise Power Density Measurement

MARKER NORMAL menu:



The *NOISE* soft key located in the right-hand supplementary menu switches the noise measurement on/off.

During a noise measurement, the noise power density is measured at the position of the reference marker. The display takes place in the marker field dependent upon the vertical units in dBx/Hz (for logarithmic scale) or in V/Hz, A/Hz or W/Hz for linear scales. The correction factors for the selected bandwidth and the conversion of the IF logarithmic converter are automatically taken into consideration.

The measurement is performed by the sampling detector which allows displaying the effective value of the noise power.

In order to produce a smoother noise display, neighboring points (symmetrical to measurement frequency) on the measurement curve are averaged.

In the time domain display, an average of the measurement values takes place in time (after each sweep).

2.9.3.1.4 Channel Power Measurements

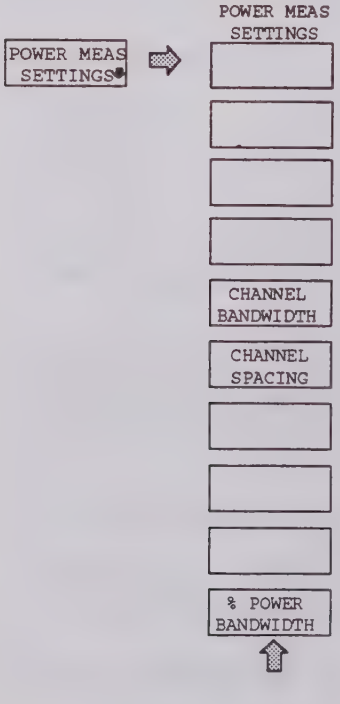
A modulated carrier is almost always used (exception e.g.,.: SSB-AM) for high-frequency transmission of information. As a result carrier modulation with information, the modulated carrier now occupies a frequency spectrum which is defined by the modulation, the transmission data rate and the filtering of the signal. Each carrier is assigned, within a transmission band, to a channel corresponding to these parameters. In order to make error-free transmission possible, each transmitter must adhere to the specified transmission parameters. Among others, these are:

- output power,
- occupied bandwidth, i.e., the bandwidth within which a defined percentage of the power must be contained and
- power output in the neighboring channels.

Using the power measurement function, the FSE is capable of measuring all the specified parameters with high precision and at high speed.

The settings for the power measurements are performed in the left-hand supplementary menu *MARKER NORMAL*.

MARKER NORMAL menu:



The following measurements can be made:

- channel power (*CHANNEL POWER*)
- signal / noise power (*C/N*)
- signal / noise power density (*C/No*)
- adjacent channel power (*ADJACENT CH POWER*)
- occupied bandwidth (*OCCUPIED BANDWIDTH*)

The channel power and the adjacent channel power can be measured either relative (*CP/ACP REL*) to the power in the utilised channel or in absolute terms (*CP/ACP ABS*).

The above mentioned power measurements can be carried out alternately.

2.9.3.1.4.1 Channel Configuration

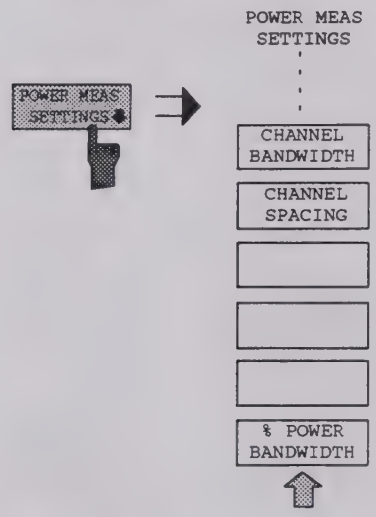
For all power measurements, a specified channel configuration is assumed which is, e.g. oriented on a specific radio communications system.

The channel configuration is defined by the nominal channel frequency (= center frequency of the FSE), the channel bandwidth (*CHANNEL BANDWIDTH*) and the channel spacing (*CHANNEL SPACING*).

The channel is indicated on the display screen by vertical lines located at a half-channel bandwidth to the left and to the right of the channel frequency.

For the adjacent channel power measurement, the adjacent channels are also indicated by vertical lines. The lines of the utilised channel are labelled with CO for easier recognition.

MARKER NORMAL - POWER MEAS SETTINGS submenu:



The *POWER MEAS SETTINGS* soft key calls the sub-menu for the definition of the channel configuration.

The *CHANNEL BANDWIDTH* soft key opens an entry window for setting the channel bandwidth.

The default setting is 14 kHz.

The *CHANNEL SPACING* soft key opens an entry window for defining the channel spacing. The channel spacing is the separation between the center frequencies of adjacent channels.

The default setting for channel spacing is 20 kHz.

The *% POWER BANDWIDTH* soft key opens an entry window for defining the percentage of the power with respect to the total power in the displayed frequency range. This defines the occupied bandwidth (percent of the total power).

The permitted range is 10 % - 99,9 %.

2.9.3.1.4.2 Channel Power Measurement

The *CHANNEL POWER* measurement is performed by an integration of the measurement points within the channel bandwidth. The channel is marked by two vertical lines to the left and to the right of the center frequency as defined by the channel bandwidth (see Fig. 2.9-1).

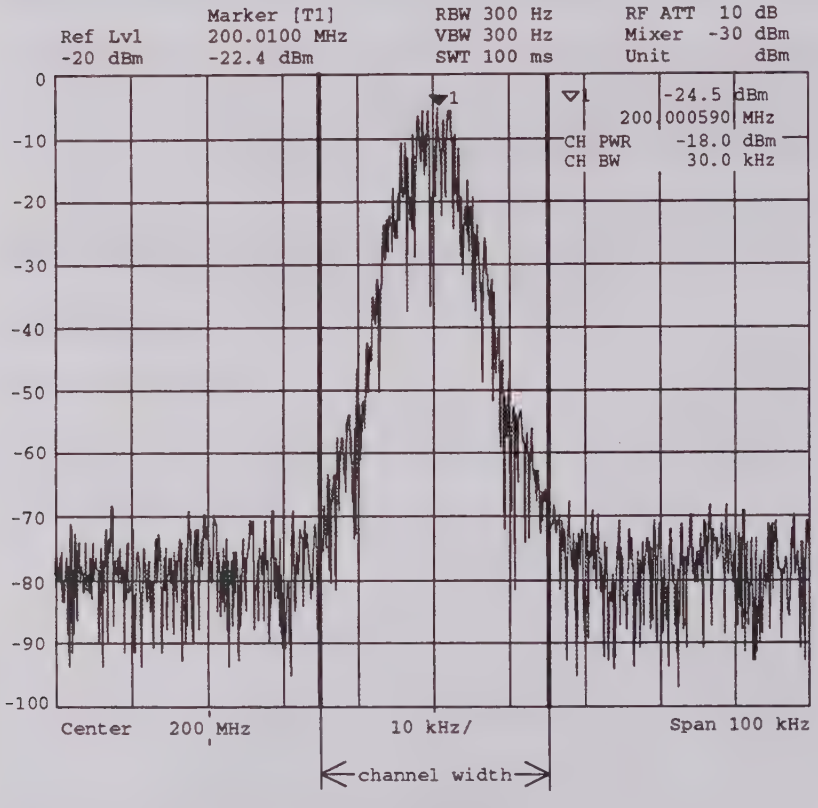


Fig. 2.9-1 Determination of the channel width.

MARKER NORMAL menu:

The *CHANNEL POWER* soft key initiates the calculation of the power in the measurement channel. The display takes place in the units of the y axis, e.g., in dBm, dBV.

The calculation is performed by summing the power at the pixels within the specified channel.

The *CP/ACP ABS/REL* soft key (Channel Power/Adjacent Channel Power Absolute /Relative) switches between an absolute and a relative display of the power measured in the channel/adjacent channel.

In *CHANNEL POWER*, the power in the currently measured channel (e.g., the utilised channel) can be defined as the reference value using the *SET CP REFERENCE* soft key.

After a corresponding change in the channel frequency (FSE center frequency), the relative power (CP/CP0 for a linear vertical axis scale) or the logarithmic ratio (20×log(CP/CP0) for a dB vertical axis scale) of the new channel to the reference channel can be measured.

Thus, CHANNEL POWER RELATIV can also be used for universal adjacent channel power measurements.

Example:
Measurement of the 'Alternate Channel Power'. This is the relative power in the channel bandwidth at ±2 × channel spacing as well as ±3 × channel spacing from the center of the channel.

For *ADJACENT CHAN POWER*, the reference value is the currently measured power in the channel (utilised channel) defined by the FSE center frequency and marked by two vertical lines (labelled with C0). The calculation of the relative measurement is performed analog to *CHANNEL POWER*.

The soft key is not available for *OCCUPIED PWR BANDWIDTH*, *C/N* and *C/N0*.

For an activated *CHANNEL POWER* power measurement, the *SET CP REFERENCE* soft key sets the reference value to the currently measured channel power.

2.9.3.1.4.3 Signal / Noise Power Measurement

MARKER NORMAL menu:

The *C/N* (Carrier to Noise) soft key calculates the ratio of carrier power to noise power and the power of interference signals in the channel defined under *POWER MEAS SETTING*. For the measurement, a marker must be set to the carrier of interest.

Pressing the *C/N* soft key sets the level of the marker to the reference level (the carrier can then be turned off at the Unit Under Test (UUT)) and then includes this value in the ratio of total power in the channel defined under *POWER MEAS SETTING*.

If the carrier level is located within the defined channel, then C/C+N is also measured.

For a correct C/N measurement, the carrier must be set either outside of the channel or the carrier must be switched off (at the UUT!).

The unit of C/N is dB when the display is logarithmic. When the display is linear, C/N is shown without a unit.

The C/N_0 soft key starts the C/N_0 measurement.
In contrast to the *C/N* measurement, C/N_0 calculates the ratio of carrier power to noise and interference signals based on a 1 Hz bandwidth in the channel defined under *POWER MEAS SETTING*. The operation is analog to *C/N*.

The unit of C/No is dB/Hz when the display is logarithmic and 1/Hz when the display is linear.

In order to display C/N or C/N_0, a marker is activated and positioned to the peak of the carrier signal (e.g., with the *Marker -> Peak* soft key). With the *FREQUENCY CENTER* and *CHANNEL BANDWIDTH* (*POWER MEAS SETTING* sub-menu) soft keys, the desired frequency range (channel) is selected.

Pressing the *C/N* or C/N_0 soft keys sets this marker to reference fixed and activates each measurement:

It must be observed that the carrier is either located outside of the measurement channel or turned off at the UUT. Otherwise, C/C+N or $C/C+N_0$ will be displayed. The measurement values for C/N or C/N_0 are displayed in the marker info field.

Note: *If no carrier marker was set, only N or N_0 with the appropriate units is displayed.*

The units of C/N and C/No depend on the current units of the y axis: if the display is logarithmic, the units are respectively dB and dB/Hz. If the display is linear, C/N is shown without a unit and C/No has the unit 1/Hz.

Example:

The signal-to-noise ratio of the carrier (f = 199.9 MHz) in the channel with +100 kHz separation from 200 MHz (channel center frequency) is to be measured. The channel bandwidth is 150 kHz.

1. Using the *CENTER* key, set the center frequency to the channel center frequency 200 MHz.
2. Using the *SPAN* key, set the span, e.g., to 1 MHz (carrier must be visible).
3. Using the *MARKER NORMAL* key, activate *MARKER 1* (If Marker 1 was not yet active, the function *MARKER→ PEAK* is automatically executed. In this case, skip step 4.)
4. Using the *MARKER→ PEAK* key, set *MARKER 1* on the carrier (assumption: the 200 MHz carrier has the highest level in the selected span).
5. Press the *MARKER NORMAL* key and change to the left-hand supplementary menu.
6. Using the *POWER MEAS SETTING* soft key, call the sub-menu for defining the measurement channel.
7. Using the *CHANNEL BANDWIDTH*: soft key, set the bandwidth to 150 kHz (The channel spacing does not need to be entered for this measurement). Then press ⇑ menu change key.
8. Using the *C/N* soft key, start the C/N measurement. In the marker info field, the outputs *CHANNEL CENTER, CHANNEL BANDWIDTH* as well as the corresponding C/N measurement values appear. *MARKER 1* is also set to reference fixed.
9. Using the *ADJUST CP SETTINGS* soft key, activate the default settings with modified channel parameters (channel bandwidth = 150kHz) for the correct C/N measurement (span = 2 × channel bandwidth = 300 kHz, RBW = 3 kHz, VBW = 10 kHz, detector: sampling).

Two vertical lines mark the channel 200 MHz ± 75 kHz in which the noise measurement is performed (see Fig. 2.9-2). The reference value is the measurement from *MARKER 1* (Reference Fixed).

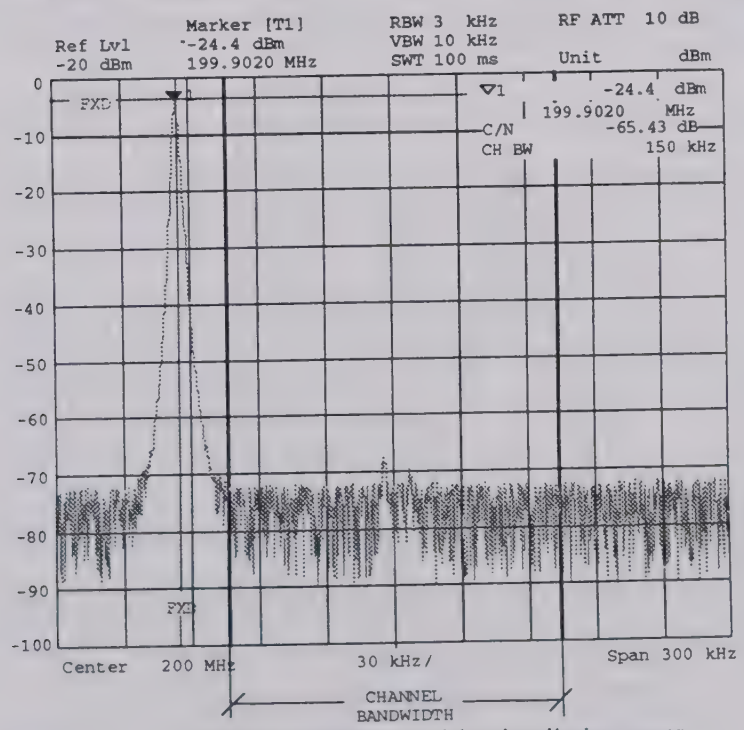


Fig.2.9-2 Example: measurement of the signal/noise power.

2.9.3.1.4.4 Adjacent Channel Power

MARKER NORMAL menu:

The *ADJACENT CHAN POWER* soft key starts the measurement of the adjacent channel power.
The *ADJACENT CHAN POWER* measures the power which the transmitter delivers to the two adjacent channels (upper channel , lower channel) and then, in each case, calculates the power ratio referred to the power in the utilised channel.
The measurement values are displayed on the vertical axis according to the setting of the *CHAN POWER ABS/REL* soft key either as an absolute value in the scale of the vertical axis or as a logarithmic ratio in dB.

Note: *The CHANNEL POWER/RELATIV function is suited for measurements of channels other than the two immediately adjacent channels (alternate channels).*

A prerequisite for the correct measurement of the adjacent channel power is the correct setting of the FSE center frequency, the channel bandwidth and the channel spacing.
The *CHANNEL SPACING* and *CHANNEL BANDWIDTH* are defined in the *POWER MEAS SETTINGS* sub-menu.
For an activated measurement of adjacent channel power, the analyzer itself optimally sets all other values (span, resolution bandwidth, detector, etc.) after the *ADJUST CP SETTINGS* soft key is pressed. The carrier power in the utilised channel, the power (absolute or relative to the utilised channel) in the upper and lower adjacent channels as well as the largest of the two power values and the channel raster with channel spacing and bandwidth are displayed as the result of the measurement. The C0 lines mark the bandwidth of the carrier channel. Other unlabelled frequency lines mark the adjacent channels (see Fig. 2.9-3).
The measurement values are updated and displayed until the *ADJACENT CHAN POWER* soft key is pressed again and the measurement of the adjacent channel power is stopped.

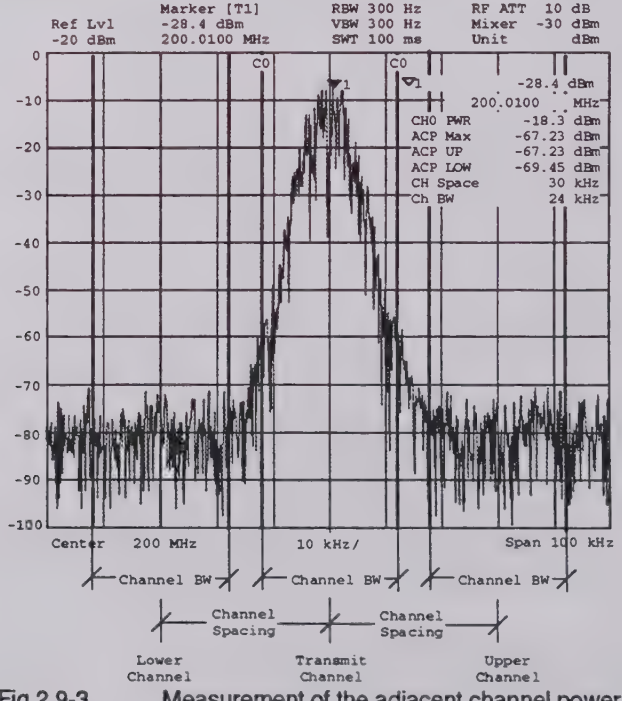


Fig.2.9-3 Measurement of the adjacent channel power.

2.9.3.1.4.5 Occupied Bandwidth Measurement

An important characteristic of a modulated signal is the bandwidth which it occupies. The occupied bandwidth must be limited in a radio communications system so that disturbance-free transmission in adjacent channels is possible. The occupied bandwidth is defined as the bandwidth in which a defined percentage of the total transmitter power is contained. The percentage of the power can be set between 10 and 99% in the FSE.

MARKER NORMAL menu:

The *OCCUPIED PWR BANDW* (occupied power bandwidth) soft key starts the measurement for determining the occupied bandwidth.
In the spectrum display mode, the bandwidth is determined in which a predefined percentage of the power in the displayed bandwidth is contained. (selectable in the *POWER MEAS SETTINGS* sub-menu with the : *% POWER BANDWIDTH* soft key). The occupied bandwidth is output to the marker display field and marked on the measurement curve with temporary markers.

Measurement procedure:

For example, the bandwidth is to be found in which 99% of the signal power is contained. The routine calculates first the total power of all displayed points (pixels) of the measurement curve. In the next step, the measurement points from the right edge of the measurement curve are integrated until 0.5% of the total power is reached. Then the FSE integrates, in an analog fashion, from the left edge of the measurement curve until 0.5% of the power is reached. The delta marker is positioned at this point. Thus, 99% of the power is located between the two markers. The difference between the two frequency markers is the occupied bandwidth which is displayed in the marker info field.

A prerequisite for the correct operation of the measurement is that **only** the signal to be measured is visible on the display screen of the FSE. An additional signal would falsify the measurement.

In order to be able to perform correct power measurements, especially for noisy signals, and thus to achieve the correct occupied bandwidth, the selection of the following parameters should be observed:

RBW	<< occupied bandwidth (≤ approx. 1/20 of the occupied bandwidth, for voice communications, typ. 300 Hz or 1 kHz)
VBW	≥ 3 x RBW
detector	sampling
span	≥ 10 x occupied bandwidth
span	≥ 100 x occupied bandwidth

According to the application or other measurement guidelines, it may be necessary or reasonable to average a definite number of sweeps in order to achieve a usable value for the occupied bandwidth.

This is provided by the *TRACE* (1....4) key group and the averaging function. With the *SWEEP COUNT* soft key, the number of averages is defined.

2.9.3.1.4.6 Parameters for Channel Power Measurements / Configuration

For the correct measurement of channel power, C/N, C/N0, adjacent channel power and occupied bandwidth, it is recommended that an automatic optimisation of the analyzer settings be performed after enabling the corresponding measurement and selecting the channel configuration (channel power settings).

MARKER NORMAL menu:

The *ADJUST CP SETTINGS* soft key optimises automatically the settings of the analyzer for the selected power measurement (see below).

Thus, all relevant analyzer settings for a power measurement within a defined frequency range (channel bandwidth) are optimally set including:

- span
- resolution bandwidth
- video bandwidth
- grid scale
- detector

dependent upon the channel configuration (channel bandwidth and, if needed, channel spacing).

The trace mathematical functions and trace averaging are switched off.

The reference level is not influenced by the automatic optimisation routine. The reference level is to be so adjusted that the signal maximum is located near the reference level.

The optimisation is performed only once, however, if necessary, the instrument settings may be changed later.

Span

The span should cover at least the frequency range that is to be observed. For measurements of channel power, C/N and C/N0, this is the channel bandwidth. For adjacent channel power measurements, this is the utilised channel bandwidth and the adjacent channels located within the channel spacing.
If the span is large compared to the observed frequency band(s), then only a few points on the measurement curve are available for the measurement.

The *ADJUST CP SETTINGS* soft key sets the span as follows:

2 × channel bandwidth	for channel power, C/N, C/No or
2 × channel spacing + channel width	for adjacent channel power

For measurements of the occupied bandwidth, the span is not influenced.

Resolution bandwidth (RBW)

In order to achieve acceptable speed as well as the necessary selection (to suppress spectral components outside of the frequency range to be measured and, especially the adjacent channels), the resolution bandwidth should not be chosen too broad or too narrow.
If the resolution bandwidth is too narrow, the measurement speed becomes very slow and it is possible that relative spectral components are not displayed (due to the sampling detector necessary for power measurements and the finite number of points).
On the other hand, the resolution bandwidth should not be so broad that, due to insufficient selection, spectral components outside of the observed frequency range (from adjacent channel) falsify the measurement results.

The *ADJUST CP SETTINGS* soft key sets the resolution bandwidth (RBW) dependent upon the channel bandwidth as follows:

RBW ≤ 1/40 of the channel bandwidth. The largest possible RBW, with due regard to the 1, 2, 3, 5 step size and the requirement RBW ≤ 1/40 will be selected.

The RBW is not influenced by measurements of the occupied bandwidth.

Video bandwidth (VBW)

Since a power measurement of the noise components is also necessary (otherwise, errors occur due to the logarithmic characteristics of the spectrum analyzer), the video bandwidth should be chosen substantially larger than the resolution bandwidth.

The *ADJUST CP SETTINGS* soft key adjusts the video bandwidth (VBW) dependent upon the channel bandwidth as follows:

VBW ≥ 3* RBW. The smallest VWB with regard to the available 1, 2, 3, 5 step size is selected.

Grid scale

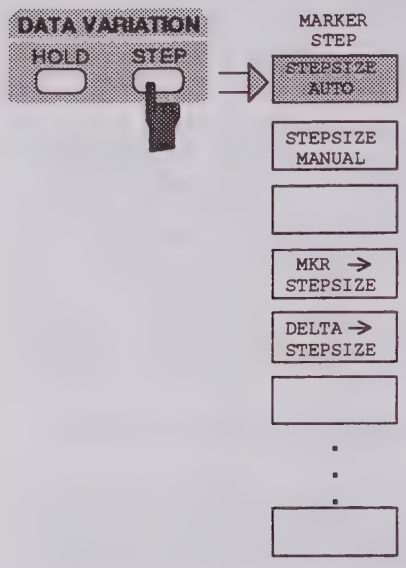
The *ADJUST CP SETTINGS* soft key sets the grid scale to the 100-dB range. Thereby, a wide dynamic range in channel power measurements is achieved.

Detector

The *ADJUST CP SETTINGS* soft key selects the sampling detector.
The sampling detector is to be selected, above all, for correct power measurements of noisy signals within the observed frequency range.

2.9.3.1.5 Marker Step Size

DATA VARIATION – STEP menu:



The *STEP* key in the *DATA VARIATION* key group opens a menu to match the marker step size to each individual application. In order to change the step size, the marker entry mode must already be active.
Control is returned to the *MARKER NORMAL* menu via the menu key.

The *STEPSIZE AUTO* soft key sets the marker step size to *AUTO*. In this case, the step size is exactly 10% of the grid. A one-raster movement of the roll-key corresponds to one pixel.

STEPSIZE AUTO is the default setting.

The *STEPSIZE MANUAL* soft key activates the entry window for defining a fixed value for the marker step size.

Pressing the step key shifts the marker position by the selected step size. The resolution of the roll-key is always one pixel per raster.

The *MKR → STEPSIZE* soft key sets the marker step size to the current marker frequency or marker time, respectively.

In the frequency domain, this function is well suited to harmonic measurements. The marker is set to the largest signal using the peak search function. After activation of the *MKR → STEPSIZE* function, the marker is set to the corresponding harmonic of the signal each time the cursor key or is pressed when entering the marker position (see also Chapter 2, section "Measurement Examples").

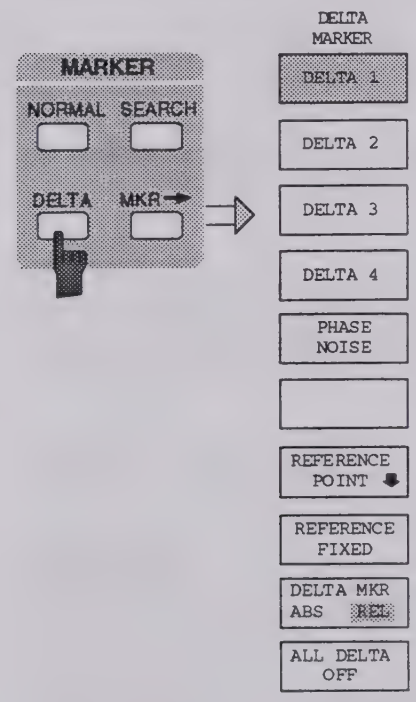
The *DELTA STEPSIZE* soft key sets the marker step size to the difference between the reference marker and the last active delta marker.

The soft key is only available when at least one delta marker is enabled.

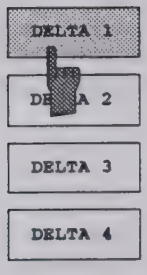
2.9.3.2 Delta Markers – *DELTA Key*

The delta markers are used to measure a level or frequency referred to a reference marker. They are always referenced to the marker whose position was last changed. A delta marker is displayed as an empty △ symbol. The reference marker is displayed as a filled ▼ symbol.

MARKER DELTA menu:



The *DELTA* key switches a delta marker on and calls the menu for its control. If no marker is enabled, *MARKER 1* is automatically activated when the delta marker is switched on. The delta marker activated to entry mode is shown on the display screen as a filled ▲ symbol.



The *DELTA 1 to 4* soft keys are used to enable delta markers 1...4. The control of the delta markers corresponds to that of the markers. After a delta marker has been enabled, all entries are now applicable to this marker. The main marker must be activated anew if its position is to be changed.

The delta marker field on the display screen contains the delta marker number, the difference frequency from the delta marker to reference marker and the level difference between the active delta markers and reference markers.

The indicated differences are, in general, referred to the reference marker. If the *PHASE NOISE* or *REFERENCE FIXED* functions are enabled, the reference values under *REFERENCE POINT* are applicable.

The *DELTA ABS REL* soft key switches between relative and absolute entry modes for the delta-marker frequency.

In the *REL* position, the delta marker frequency is entered relative to the reference marker. In this case, the entry mode for the delta-marker frequencies is also relative.

In the *ABS* position, the entry of the delta-marker frequency is in terms of absolute frequency.

The default setting is *REL*.

The *ALL DELTA OFF* soft key switches off all active delta markers and any associated functions (e.g. *REFERENCE FIXED*, *PHASE NOISE*).

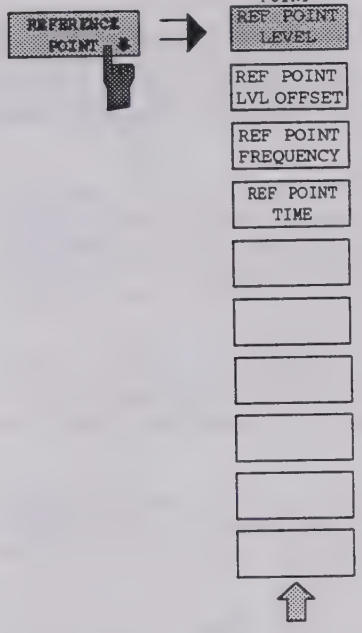
The *REFERENCE FIXED* soft key enables/disables relative measurements with respect to a fixed, measurement-curve-independent reference value. Therefore, the information in the delta-marker field on the display screen is not referenced to the reference marker, but rather to this fixed reference value.

When *REFERENCE FIXED* is enabled, the current settings of the reference marker become the reference values. If no marker is active, *MARKER 1* (with peak search) is activated. The reference value can be subsequently shifted as desired in the *REFERENCE POINT* sub-menu.

After transferring the reference values, all markers are deleted, and the active delta marker is set to the marker position. For *REFERENCE FIXED*, the *REF POINT* is handled as a reference marker not bound to the measurement curve. This means, that it will be shown in the *NORMAL* menu as enabled and can also be changed in position. In this case, the coordinates of the *REF POINT* are overwritten by the marker values (they lie, by definition, on the measurement curve). Thus, it is possible, even for an enabled *REFERENCE FIXED*, to define a new reference point function with search functions.

After activation of the *REFERENCE FIXED* function, additional delta markers can be switched on. For the generation of the marker lists using *MARKER INFO* or *MARKER LIST*, the delta markers are output relative to a fixed reference. In the lists, the *REFERENCE POINT* is tagged by the number of the reference marker (only one enabled).

MARKER DELTA- REFERENCE POINT submenu:



The *REFERENCE POINT* soft key opens a sub-menu in which the reference value the *REFERENCE FIXED* and *PHASE NOISE* functions can be modified.

The position of the reference value is indicated by two additional display lines (horizontal and vertical). In addition, an offset level may be defined which is added to each difference during output.

The soft key is only available when the *REFERENCE FIXED* or *PHASE NOISE* function is switched on.

The *REF POINT LEVEL* soft key activates an entry box for setting the reference level relevant to the *REFERENCE FIXED* or *PHASE NOISE.* functions.

The *REF POINT FREQUENCY* soft key activates the entry box for the input of a reference frequency for the *REFERENCE FIXED* or *PHASE NOISE.* functions.

The *REF POINT LVL OFFSET* soft key activates the entry box for the entry of an additional offset level during output when the *REFERENCE FIXED* or *PHASE NOISE.* functions are enabled.

The offset level is set to 0 dB when the *REFERENCE FIXED* or *PHASE NOISE.* functions are switched on.

The *REF POINT TIME* soft key activates the entry box for the input of a reference time for the *REFERENCE FIXED* function in the time domain (span = 0).

The entry of a reference time for the *PHASE NOISE* function is not possible.

2.9.3.2.1 Phase Noise Measurement

MARKER DELTA menu:

The *PHASE NOISE* soft key switches the *PHASE NOISE* function on/off. Enabling the *PHASE NOISE* function causes the frequency and level of the reference marker to be transferred as reference values. If the *REFERENCE FIXED* function is active prior to enabling the *PHASE NOISE* function, this reference value will be kept.

The difference between this reference point and the active delta markers is determined and displayed, with due consideration of selected bandwidth and correction factors in dBc/Hz. The reference value can be subsequently changed in the *REF POINT* menu. The delta marker field on the display screen shows the difference between the reference value and the current delta marker.

For phase noise measurements, the correction factors for bandwidth and the logarithmic converter are automatically taken into consideration. The sampling detector is also enabled to allow the effective noise power to be displayed.

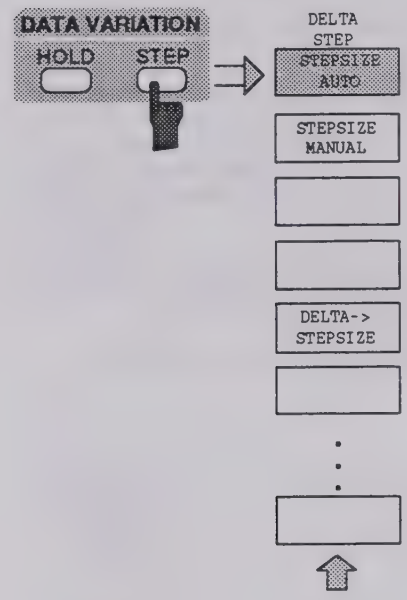
If no marker is present when the *PHASE NOISE* function is enabled, *MARKER* 1 is automatically switched on (peak search), and the marker values are saved as reference values. These can be changed later in the *REFERENCE POINT* sub-menu.

The reference value is handled in exactly the same way as for the *REFERENCE FIXED* function. In the *NORMAL* menu, the reference marker is shown as enabled. The reference marker can now be shifted and overwrites the coordinates of the *REF POINT*. Turning on an additional marker causes the *PHASE NOISE* function to be disabled.

If several delta markers are enabled, only the measurement value output of the active marker is shown in the marker field. Using *MARKER INFO* and *MARKER LIST* the measurement data of all delta markers can be displayed.

2.9.3.2.2 Delta-Marker Step Size - *STEP Key*

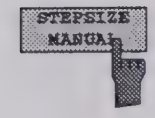
STEP-DELTA STEP menu:



The *STEP* key in the *DATA VARIATION* key group opens a menu to match the step size of the individual delta markers to the specific application. In order to change the step size, the entry mode for a delta marker must already be active.

Control is returned to the DELTA MARKER menu via the menu key.

The *STEPSIZE AUTO* soft key sets the delta marker step size to *AUTO*. In this case, the step size of the delta marker is exactly 10% of the grid. The roll-key corresponds to 1/500, i.e., for each rotational pulse, the delta marker is shifted one pixel position.



The *STEPSIZE MANUAL* soft key permits the entry of a fixed value for the delta marker step size.

Pressing the step-key shifts the marker position by the selected step size. The roll-key resolution, however, always remains constant at 1 pixel.

The *DELTA→STEPSIZE* soft key sets the delta marker step size to a quantity equal to the difference between the delta and reference markers.

The soft key is only presented when at least one delta marker is switched on.

2.9.3.3 Search Functions – SEARCH Key

The FSE offers numerous functions useful for peak/min. peak searching. The search functions can be used for marker as well as delta marker functions.

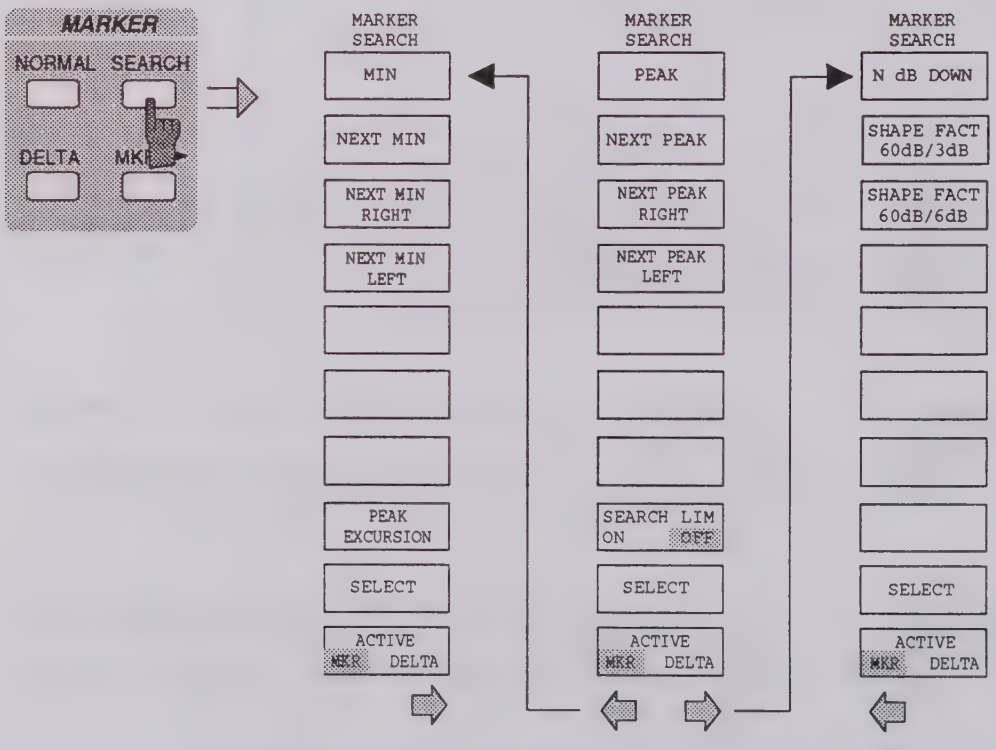
The setups applicable to the available search functions are performed in the *MARKER-SEARCH* menu.

The search functions are always related to the currently active marker. If the *SEARCH* key is pressed while the marker entry mode is active, then all search functions are related to the current reference marker. If the entry mode of a delta marker is active, then the functions will be applied to the corresponding delta marker. For the case where no marker is active, *MARKER* 1 will be automatically enabled (with peak search). The *ACTIVE MKR / DELTA* soft key allows toggling between the active marker and the active delta marker.

If the threshold line is turned on, the peak/min. search functions will only evaluate signals which have a level above/below the selected threshold. In addition, the search range can also be limited (*SEARCH LIM ON/OFF* soft key) by the frequency/time lines (*FREQUENCY LINE 1/2, TIME LINE 1/2*).

For all peak search functions, the first local oscillator is omitted at 0 Hz if it happens to be displayed.

MARKER SEARCH menu:

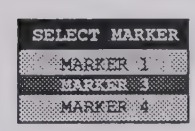


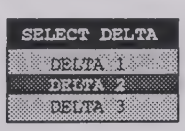
The *ACTIVE MKR / DELTA* soft key toggles between the active marker and the active delta marker.

If *DELTA* is illuminated, the following search functions are performed with the active delta marker.

Note: *Switching between marker and delta marker entry modes may also be performed using the NORMAL and DELTA keys.*

The *SELECT* soft key activates the selection of the marker/delta markers. The selection box lists the currently enabled markers/delta markers.





The *PEAK* soft key sets the active marker/delta marker to the maximum displayed value on the corresponding trace.

The *NEXT PEAK* soft key sets the active marker/delta marker to the next lower peak value on the corresponding curve.

The *NEXT PEAK RIGHT* soft key sets the active marker to the next peak to the right of the current marker position.

The *NEXT PEAK LEFT* soft key sets the active marker to the next peak to the left of the current marker position.

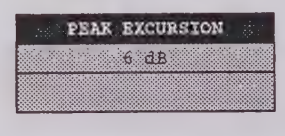
The *MIN* soft key sets the active marker to the lowest displayed peak on the corresponding measurement curve.

The *NEXT MIN* soft key sets the active marker to the next higher of the low peaks on the corresponding measurement curve.

The *NEXT MIN RIGHT* soft key set the active marker to the next low peak to the right of the current marker position.

The *NEXT MIN LEFT* soft key sets the active marker to the next low peak to the left of the current marker position.

The *PEAK EXCURSION* softkey activates the entry box which sets the minimum amount a signal level must decrease/increase before it is recognised by the search functions (except PEAK and MIN) as a maximum or minimum.



Input values from 0.1 dB to 80 dB are allowed. Incorrect inputs are rounded accordingly.

The peak excursion is preset to 6 dB. This is completely sufficient for the functions *NEXT PEAK* (or *NEXT MIN*) as always the next smaller (or higher) signal is searched four.

Functions *NEXT PEAK LEFT* and *NEXT PEAK RIGHT* (or *NEXT MIN LEFT and NEXT MIN RIGHT*) search for the next relative maximum (or minimum) independent of the current signal amplitude.
As for wide bandwidths, the set 6-dB level change is already reached by the noise indication of the analyzer, the noise values are also identified as peak. In this case, *PEAK EXCURSION* has to be selected with a higher value than the difference between the highest and lowest noise indication values.

The following example shows the effect of different *PEAK EXCURSION* settings.

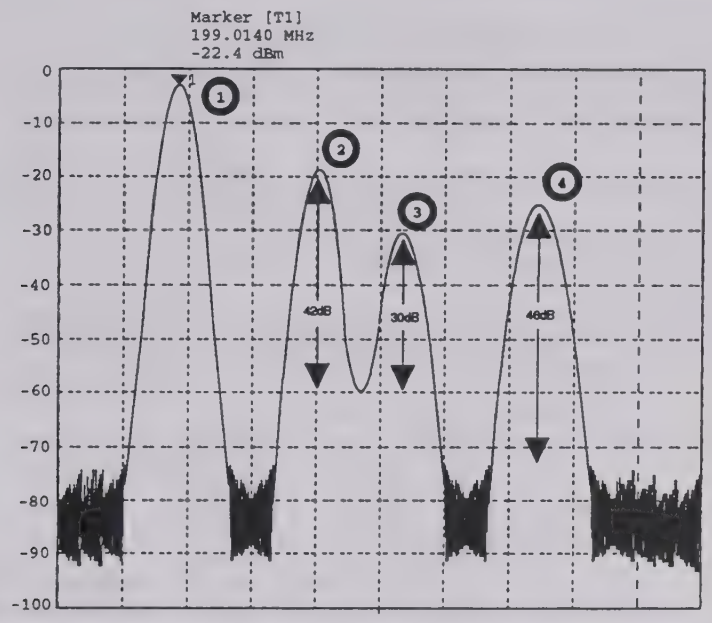


Fig. 2.9-4 Example for level measurements at different peak excursion settings

Maximum relative level change of the measured signals:

Signal 2:	42dB
Signal 3	30dB
Signal 4:	46dB

Setting **Peak Excursion 40dB** causes signal 2 and 4 to be detected with *NEXT PEAK* or *NEXT PEAK RIGHT*. Signal 3 is not detected since it is only decreased by 30 dB before the level rises again.

Order of signals found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Signal 2
NEXT PEAK RIGHT:	Signal 4

Setting **Peak Excursion 20dB** causes signal 3 to be detected since its highest level change of 30 dB is now higher than the set peak excursion.

Order of signals found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4
NEXT PEAK:	Signal 3

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Signal 2
NEXT PEAK RIGHT:	Signal 3
NEXT PEAK RIGHT:	Signal 4

Setting **Peak Excursion 6dB** recognizes all the signals, *NEXT PEAK RIGHT* does not work as required.

Order of signals found:

PEAK:	Signal 1
NEXT PEAK:	Signal 2
NEXT PEAK:	Signal 4
NEXT PEAK:	Signal 3

or

PEAK:	Signal 1
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2
NEXT PEAK RIGHT:	Marker in noise between signal 1 and signal 2

The *SEARCH LIMIT ON/OFF* soft key switches between a limited (*ON*) and unlimited (*OFF*) search range.

For peak and min. search functions, the search range can also be limited by the frequency and time lines (FREQUENCY LINE 1, 2/TIME LINE 1, 2). If *SEARCH LIMIT = ON*, the appropriate signal level will only be searched for between the specified frequency/time lines.

The default setting is *SEARCH LIMIT = OFF*.

When only one line is enabled, frequency/time line 1 is defined as the lower limit and the upper limit is defined by the stop frequency. If frequency/time line 2 turned on, then it determines the upper limit.

For the case in which no line is active the search range is unlimited.

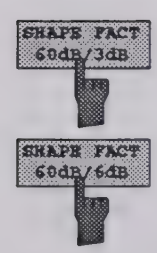
The *N dB DOWN* soft key automatically activates the temporary markers T1 and T2 which are located n dB below the active reference marker. The marker T1 is located to the left, the marker T2 is located to the right of the reference marker. The value n can be entered in an entry window. The default value is 6 dB.

The frequency difference between the two temporary markers is shown in the level output field on the display screen.
If, e.g., due to the noise level, it is not possible to find the frequency difference for the n dB value, the measurement will be marked as invalid.

Entry mode is switched to the reference marker for the case in which the delta maker entry mode is to be active. The position of the reference marker can be changed in the usual way (numeric input, step-keys, roll-key, peak search, etc.).

When additional markers or delta markers are enabled, the *N dB DOWN* function is disabled..

Pressing the *N dB DOWN* soft key again switches the function off, however, the entry function for the reference marker remains turned on.



The *SHAPE FACT 60dB/3dB*.and *SHAPE FACT 60dB/6dB* soft keys activate the automatic measurement of the form factor for the displayed signals.

For this purpose, four temporary markers are used. The markers T1 to T4 indicate, in increasing order, the 3 dB/6 dB positions below the reference marker level.

In the level output field, the relationship between the two frequency differences $\Delta f_{60dB} / \Delta f_{3dB}$ and $\Delta f_{60dB} / \Delta f_{6dB}$ are displayed

The display of the measurement value takes place in the marker field. When the level differences cannot be determined, the measurement value is marked as invalid. The update of the shape-factor display takes place at the end of sweep.

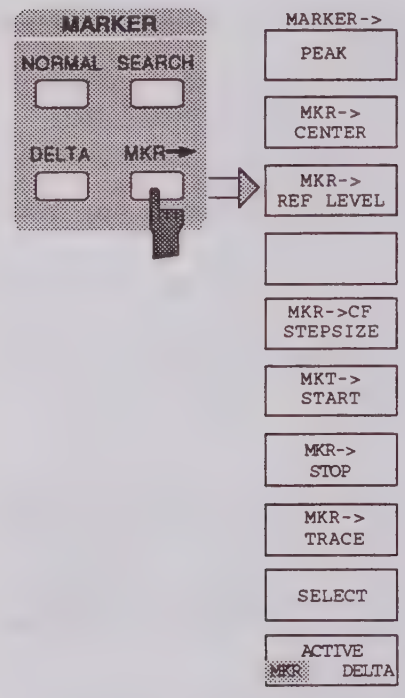
The entry mode is switched to the reference marker if the delta marker entry mode is to be active. The position of the reference marker can be changed in the usual way (numeric input, step-keys, roll-key, peak search, etc.).

The *SHAPE FACTOR* function is turned off by pressing *SHAPE FACTOR* soft key once again, or by enabling another marker.

The *SHAPE FACTOR* function is available only in the frequency domain.

2.9.3.4 Instrument Parameter Changes via Markers – *MKR →* Key

*MARKER MKR →*menu:



The *MKR →* menu offers functions through which instrument parameters can be changed with the aid of the currently active marker. Exactly as in the *SEARCH* menu, these functions can also be applied to the delta markers.

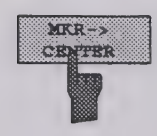
The choice between marker and delta marker is made according to the currently active frequency entry mode for the marker/delta marker. If no entry mode is active, the marker with the lowest number will be activated as the reference marker.

The *ACTIVE MKR /DELTA* soft key toggles between the active marker and the active delta marker.

If *DELTA* is illuminated, the following marker functions are carried out with the active delta marker.

Note: *Switching between marker and delta marker can also be done with the NORMAL and DELTA keys.*

To simplify control, the *PEAK* search function (see section "Search Functions - *SEARCH Key")* is also available in the *MRK→* menu. Thus, the most important functions *MARKER→PEAK*, *MKR→CENTER* and *MKR→ REF LEVEL* can be selected in one menu.



The *MKR→CENTER* soft key sets the center frequency for the current marker/delta marker .

The soft key is not available in the time domain.

The *MKR→REF LEVEL* soft key sets the reference level to that of the current marker.

The *MKR→CF STEPSIZE* soft key sets the step size for the center frequency entry mode to the current marker frequency, and also sets step-size adaptation to *MANUAL*. The *CF STEP SIZE* remains at this value until the center frequency entry mode in the STEP menu is switched from *MANUAL* to *AUTO* again.

The *MKR→CF STEPSIZE* function is, above all, helpful in the measurement of harmonics with large dynamic range (narrow bandwidth and narrow span).

The soft key is not available in the time domain.

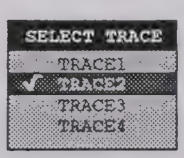
The *MKR→START* soft key sets the start frequency to the current marker frequency.

The soft key is not available in the time domain.

The *MKR→STOP* soft key sets the stop frequency to the current marker frequency.

The soft key is not available in the time domain.

The *MKR→TRACE* soft key opens a selection window through which the marker can be set to a new measurement curve. The traces available for selection appear in the window.



2.9.4 Setup of Display and Limit Lines – *LINES* Key Field

2.9.4.1 Display Lines – *D LINES Key*

Display lines are aids which, similar to markers, make the evaluation of measurement curve data more convenient. The function of display lines is similar to that of a movable scale which can be used to measure absolute and differential values on measurement curves.
In addition, the display lines can also be used to limit the range of search for marker functions.

The FSE provides four different types of display lines:

- two horizontal threshold lines for setting levels or for defining level search ranges – Display Line 1/2,
- two vertical frequency/time lines for indicating frequencies/times or for determining frequency or time search ranges – Frequency/Time Line 1/2,
- a threshold line which, for example, sets the search threshold for maximum levels (Peak Search) – Threshold Line
- a reference line which serves as the basis for mathematical correlation between measurement curves – Reference Line

For purposes of clarity, each line is annotated on the right side of the display diagram by the following abbreviations:

D1	Display Line 1	T1	Time Line 1
D2	Display Line 2	T2	Time Line 2
F1	Frequency Line 1	TH	Threshold Line
F2	Frequency Line 2	REF	Reference Line

The lines for level, threshold and reference are displayed as continuous, horizontal lines over the full width of the diagram. They are movable in the y-direction.
The lines for frequency and time are displayed as vertical, continuous lines over the total height of the diagram. They are movable in the x-direction.

For measurement operations in two separate windows, (Split Screen-Modus), the display lines are available independently in both windows. In the currently active window, the display lines can be activated and/or shifted. Lines previously defined in the currently inactive window remain unchanged.

An information field displays the absolute positions of all defined display lines. If two lines of the same type are switched on, the information field displays, in addition, the level, frequency/time differentials of the defined lines. The information field in the active measurement window is enabled/disabled by using the *SHOW LINE INFO* soft key. It then appears at the left edge of the display screen and remains fixed, even if the other measurement window is selected.

The *LINES-D LINES* menu, used for switching on and setting the display lines, is dedicated to the chosen display in the active measurement window (span or time). For the display of a spectrum (span $\neq 0$), the *FREQUENCY LINE 1* and *FREQUENCY LINE 2* soft keys appear, For the time display (span = 0), the *TIME LINE 1* and *TIME LINE 2* soft keys are displayed.

Note: *The soft keys for setting and switching the display lines on and off operate similar to a three-position switch:*

Initial condition: The line is switched off (soft key has grey background)

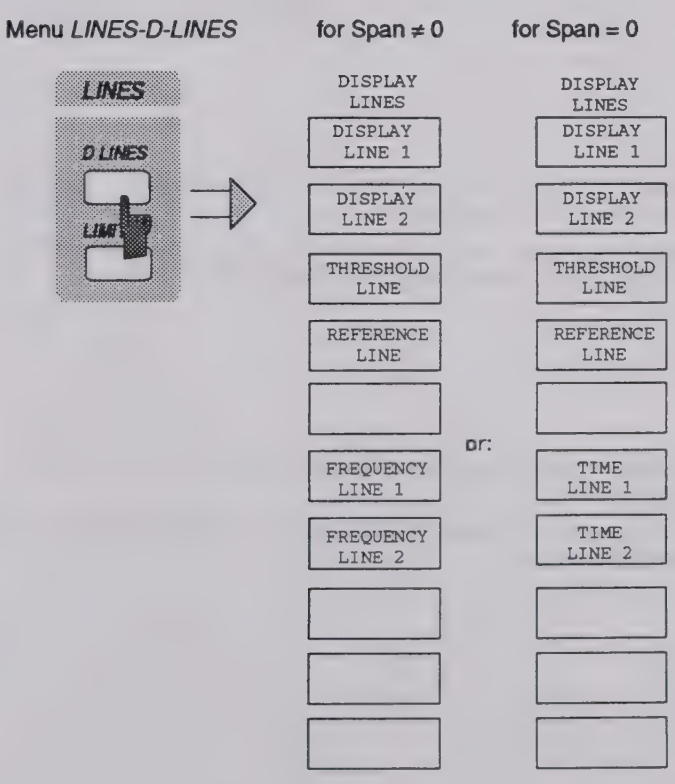
1st press: The line is switched on (soft key has red background) and data entry is activated. The position of the display line can be adjusted by using the roll-key, the step keys or through direct numerical inputs via the data-entry keypad. If some other arbitrary function is requested, the data-entry keypad is disabled. In this case, the display line remains switched on (soft key has green background).

2nd press: The display line is switched off (soft key has grey background).

Initial condition: The line is switched on (soft key has green background)

1st press: The line is switched on (soft key has red background) and data entry is activated. The position of the display line can be adjusted by using the roll-key, the step keys or through direct numerical inputs via the data-entry keypad. If any other arbitrary function is requested, the data-entry keypad is disabled. In this case, the display line remains switched on (soft key has green background).

2nd press: The display line is switched off (soft key has grey background).



The *DISPLAY LINE 1/2* soft keys switch the display lines on/off and activate the entry of the line location.

The display lines mark the selected levels in the measurement window.

The *THRESHOLD LINE* soft key switches the threshold line on/off and activates the entry of the line location.

The threshold line is a display line which defines a threshold value. This threshold value serves as a lower search limit for maximums/minimums in the marker functions (*MAX PEAK, MIN PEAK, NEXT PEAK* etc.). For signal tracking (*SIGNAL TRACK function*), this threshold value defines the lower search limit (see section "Marker Functions")..

The *REFERENCE LINE* soft key switches the reference line on/off and activates the entry of the line position.

The reference line serves as the basis for mathematical correlation between measurement curve data (see section "Mathematical Operations on Measurement Curves"

The *FREQUENCY LINE 1/2* soft keys switch the frequency lines 1/2 on/off and activate the entry of the line locations.

The frequency lines mark the selected frequencies in the measurement window or define search ranges (see section "Marker Functions").

The *TIME LINE 1/2* soft keys switch the time lines 1/2 on/off and activate the entry of line locations.

The time lines mark the selected times or define the search range (see section "Marker Functions").

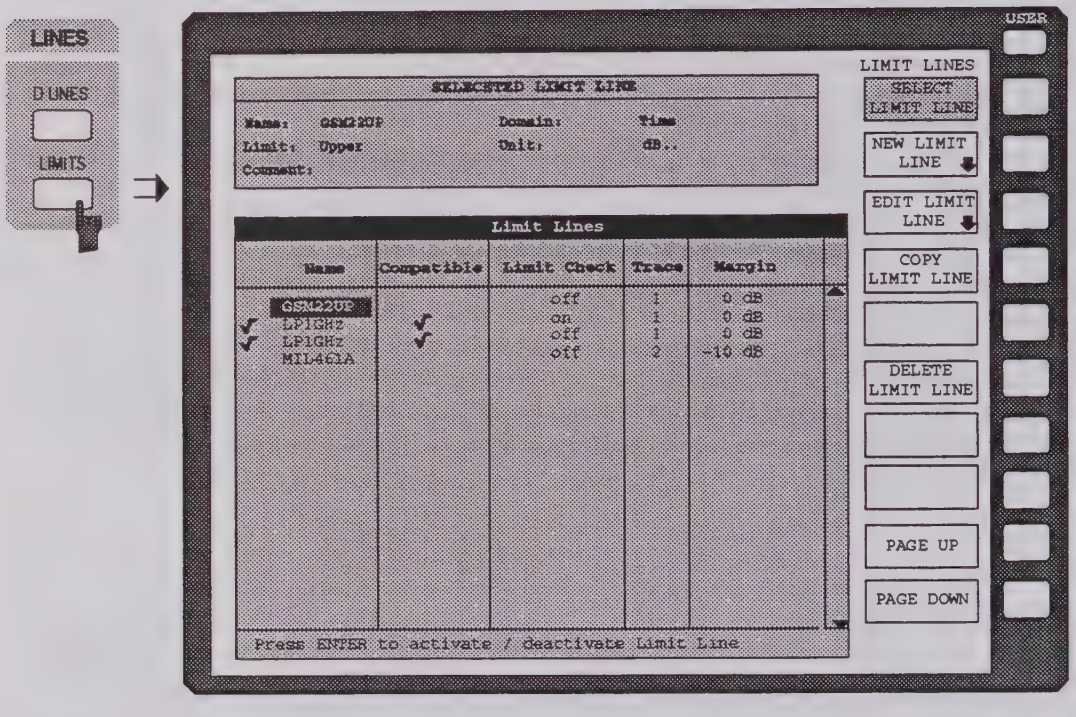
2.9.4.2 Limit Lines – *LIMITS Key*

Limit lines are used to define amplitude curves or spectral distribution boundaries on the display screen which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are permissible from a Unit Under Test (UUT). For transmission of information in TDMA (e.g., GSM), the amplitude of the bursts in a time slot must adhere to a curve which must fall within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).
The FSE instrument supports up to 300 limit lines, each of which may have a maximum of 50 data points. For each limit line, the following characteristics must be defined:

- The name of the limit line. The limit line data are stored under this name and can be examined in the table *LIMIT LINES.*
- The domain in which the limit line is to be used. Here, a distinction is made between the time domain (span = 0 Hz) and the frequency domain (span > 0 Hz).
- The type of limit line (upper or lower limit). With this information and the active limit checking function (*LIMIT CHECK soft key*), the FSE checks for compliance with each limit.
- The limit line units to be used. The units of the limit line must be compatible with the level axis in the active measurement window.
- The measurement curve (trace) to which the limit line is assigned. For the FSE, this defines the curve to which the limit is to be applied when several traces are simultaneously displayed.
- For each limit line, a margin can be defined which serves as a threshold for automatic evaluation.
- In addition, commentary can be written for each limit line, e.g., a description of the application.

In the *LINES LIMIT* menu, the compatible limit lines can be enabled in the *LIMIT LINES* table. The *SELECTED LIMIT LINE* display field provides information concerning the characteristics of the marked limit lines. New limit lines can be specified and edited in the *NEW LIMIT LINE and EDIT LIMIT LINE* sub-menus, respectively.

LINES LIMIT menu



2.9.4.2.1 Limit Line Selection

The *SELECTED LIMIT LINES* table provides information about the characteristics of the marked limit line :

Name	name
Domain	frequency or time
Unit	vertical scale
Limit	upper/lower limit
Comment	commentary

The characteristics of the limit line are set in the *EDIT LIMIT LINE (=NEW LIMIT LINE)* sub-menu.

The *SELECT LIMIT LINE* soft key activates the *LIMIT LINES* table and the selection bar jumps to the uppermost name in the table.

The following entries are made in the columns of the table:

Name	Enable the limit line.
Compatible	Indicates if the limit line is compatible with the currently active measurement window.
Limit Check	Activate automatic violation check for upper/lower limits.
Trace	Select the measurement curve to which the limit is assigned.
Margin	Define margin.

***Name and Compatible* - Enabling limit lines**

A maximum of 8 limit lines can be enabled at any one time. A check mark at the left edge of a cell indicates that this limit line is enabled. A limit line can only be enabled when it has a check mark in the *Compatible* column, i.e., only when the horizontal display (time or frequency) and vertical scales are ***identical*** to those of the display in the active measurement window.

If the scale of the y-axis or the domain (frequency or time axis) are changed, all non-compatible limit lines are automatically switched off in order to avoid misinterpretation. The limit lines must be enabled anew when the original display is re-displayed.

***Limit Check* - Activate automatic limit violation check**

When *LIMIT CHECK ON* is activated, a GO/NOGO test is performed. In the center of the diagram, a display window appears which indicates the results of the limit check test:

LIMIT CHECK: PASSED	No violations of active limits.
LIMIT CHECK: FAILED	One or more active limit lines were violated. The message contains the names of the limit lines which were violated or whose margins were not complied with.
LIMIT CHECK: MARGIN	The margin of at least one active limit lines was not complied with, however, no limit line was violated. The message contains the names of the limit lines whose margins were not complied with.

The following example shows three active limit lines:

```
LIMIT CHECK: FAILED

LINE VHF_MASK: Failed
LINE UHF2MASK: Margin
```

A check for violations of limit lines takes place only if the limit line of the assigned measurement curve (trace) is enabled.
If *LIM CHECK* is set to *OFF* for all active limit lines, then the limit line check is not executed and the display window is activated.

***Trace* - Select the measurement curve to which the limit line is assigned.**

The selection of the measurement curve (trace) takes place in an entry window. Allowed are the integer entries 1, 2, 3 or 4. The default setting is trace 1. If the selected limit line is not compatible with the assigned measurement curve or the measurement curve is not active, then the limit line is disabled. (display and limit check).

***Margin* - Setting a margin.**

The margin is defined as the signal-level distance to the limit line . When the limit line is defined as an upper limit, a positive margin means that the level is below the limit line, and a negative margin means that the level is above the limit line. When the limit line is defined as a lower limit, a positive margin means that the level is above the limit line, and a negative margin means that the level is below the limit line. The default setting is 0 dB (i.e., no margin).

The *COPY LIMIT LINE* soft key copies the data file describing the marked limit line and saves it under a new name. In this way, a new limit line can be easily generated by parallel translation or editing of an existing limit line. The name can be arbitrarily chosen and input via an entry window (max. of 8 characters).

Pressing the *DELETE LIMIT LINE* soft key erases the selected limit line. Before deletion, a message appears requesting confirmation.

Pressing the *PAGE UP* soft key sets the limit line table to the next page.

Pressing the *PAGE DOWN* soft key sets the limit line table to the previous page.

2.9.4.2.2 Entry and Editing of Limit Lines

A limit line is characterized by

- its name
- the assignment of domain (frequency or time)
- the vertical scale
- the definition of the limit line as either upper or lower limit.
- the data points for frequency/time and level

At the time of entry, the FSE immediately checks that all limit lines are in accordance with certain guidelines. These guidelines must be observed if specified operation is to be guaranteed.

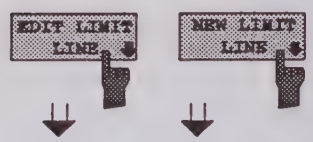
- The frequencies/times for each data point must be entered in ascending order, however, for any single frequency/time, several data points may be input (vertical segment of a limit line).

  The data points are allocated in order of ascending frequency/time. Gaps are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.

- The entered frequencies/times must not necessarily be selectable in FSE. A limit line may also exceed the specified frequency or time domains. The minimum frequency for a data point is 0 Hz, the maximum frequency is 200 GHz. For the time domain representation, negative times may also be entered. The allowable range is -1000 s to +1000 s.

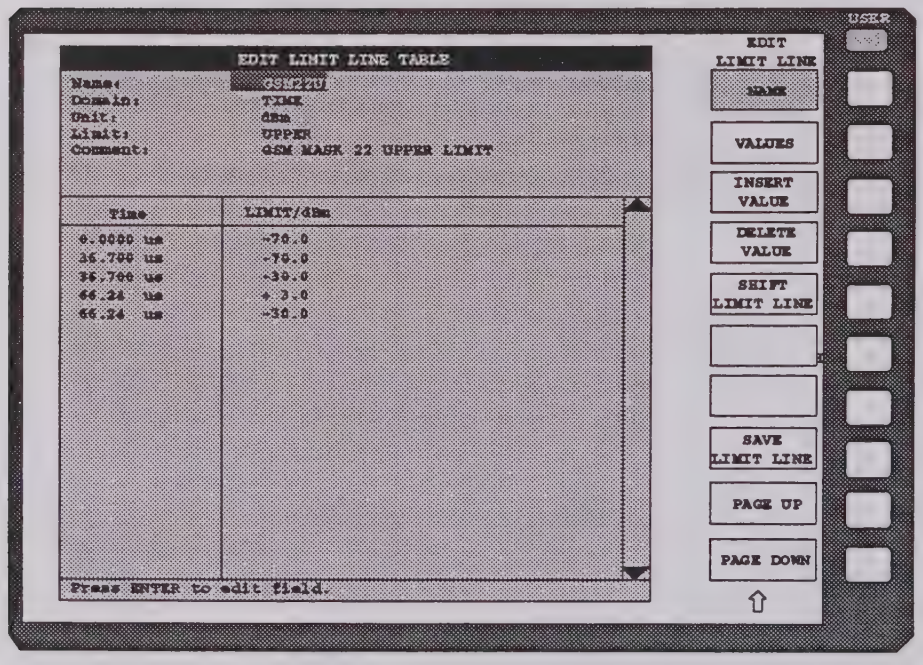
- The minimum/maximum value for a limit line is -200 dB to +200 dB for the logarithmic or 10^{-20} to 10^{+20} or-99.9% to + 999.9% for the linear amplitude scales.

LINES LIMIT-EDIT LIMIT LINE menu



The *EDIT LIMIT LINE* and *NEW LIMIT LINE* soft keys both call the *EDIT LIMIT LINE* sub-menu used for editing limit lines. In the table heading, the characteristics of the limit line can be entered. The data points for frequency/time and level values are entered in the columns.

Name	Enter name.
Domain	Select domain.
Unit	Select units.
Limit	Select upper/lower limit.
Comment	Enter comments.
Time/Frequency	Enter time/frequency for the data points.
Limit/dBm	Enter magnitudes for the data points.



The *NAME* soft key enables the entry of characteristics in the table heading.

***Name* - Enter name**

A maximum of 8 characters are permitted for each name. All names must be compatible with the MS DOS conventions for file names. The instrument stores all limit lines with the .LIM extension.

***Domain* - Select time or frequency domain**

A change in domain (frequency/time) is only permitted when the data point table is empty. The default setting is frequency.

***Unit* - Select the vertical scale units for the limit line**

The selection of units takes place in a selection box. The default setting is dBm.

***Limit* - Select upper/lower limit**

A limit line can be defined as either an upper or lower limit.

***Comment* - Enter comments**

Comments are arbitrary, however, they must be less than 40 characters long.

The *VALUES* soft key activates the entry of the data points in the table columns *Time/Frequency* and *Limit/dBm*. Which table columns appear depends upon the *Domain* selection in the table heading.

The desired frequency/time data points are entered in ascending order (repeated frequencies/time values are permitted).

The *INSERT VALUE* soft key creates an empty line above the current cursor position where a new data point may be entered. However, during the entry of new values, it is necessary to observe an ascending order for frequency/time.

The *DELETE VALUE* soft key erases the data point (complete line) at the cursor position. All succeeding data points are shifted down accordingly.

The *SHIFT LINE* soft key calls an entry window where a complete limit line may be shifted parallel in the vertical direction.

The shift takes place according to the vertical scale:

- for logarithmic units, relative, in dB
- for linear units, as a factor

In this manner, a new limit line can be easily generated based upon an existing limit line which has been shifted vertically and stored (*SAVE LIMIT LINE* soft key).under a new name (*NAME* soft key).

The *SAVE LIMIT LINE* soft key stores the currently edited limit line . The name can be entered in an input window (max. 8 characters)

Pressing the *PAGE UP* soft key displays the next page of data points.

Pressing the *PAGE DOWN* soft key displays the previous page of data points.

2.9.5 Trace Selection and Setup – *TRACE Key Group*

The FSE is capable of displaying up to four separate traces at the same time. A trace consists of a maximum of 500 pixels on the horizontal axis (frequency or time). If there are more measurement values than pixels available, then several measurement values are collected together in one pixel.

The traces are selected using keys 1 to 4 of the *TRACES* key group. When two measurement windows (*SPLIT SCREEN*) are displayed, traces 1 and 3 are assigned to the upper (*SCREEN A)* and traces 2 and 4 are assigned to the lower (*SCREEN B)* measurement window.

The traces can be individually enabled for a measurement and, after the measurement is completed, held fixed. Traces which are not enabled remain dark.

For each trace, the type of display is selectable. The traces can be overwritten (CLEAR/WRITE mode) at each measurement, averaged (AVERAGE mode) over several measurements, or a maximum/ minimum value from several measurements can be determined and displayed.

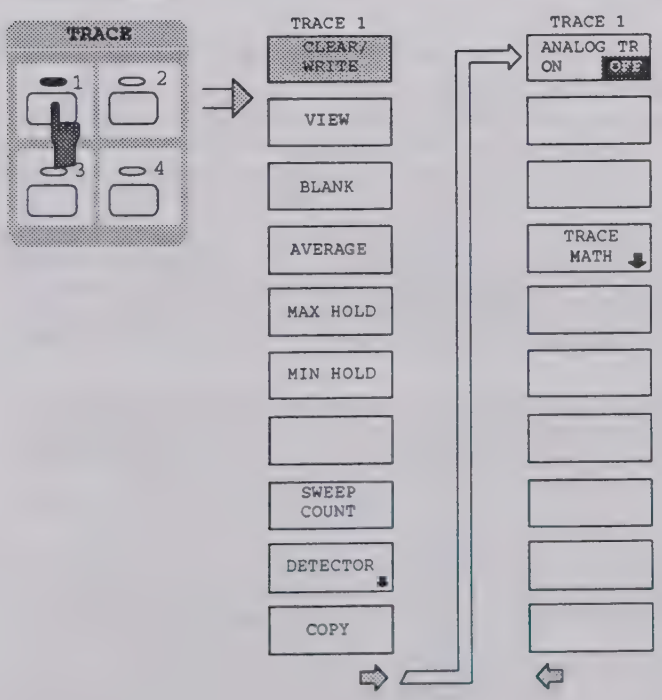
Individual detectors are selectable for the various traces. The auto-peak detector displays maximum and minimum values connected by a vertical line. The max-peak detector and min-peak detector display the maximum value/minimum value of the level within a pixel. The sampling detector displays the instantaneous value of the level at a pixel.

2.9.5.1 Measurement Function Selection - *TRACE 1 to 4* key

The trace functions are partitioned as follows:

- type of trace display (CLEAR/WRITE, VIEW and BLANK)
- evaluation of the trace as a whole (AVERAGE, MAX HOLD and MIN HOLD)
- evaluation of the individual pixels of a trace (AUTOPEAK, MAX PEAK, MIN PEAK and SAMPLE)

TRACE 1 menu



The *TRACE* keys 1...4 call a menu which presents the options for the selected trace.

In this menu, the method to be used for compressing the measurement data in the frequency or time domain to the 500 representable points of the display is determined.

At the beginning of the measurement, each trace can be displayed either completely new or based on previous measurement results.

Traces can be displayed, blanked and copied.

By applying mathematical functions, the traces can also be corrected.

The measurement detector for each of the display types may be chosen either directly or selected automatically by the FSE.

All activated traces are marked with a LED at the corresponding key (here, *TRACE 1)*. The default setting is *TRACE 1* with *CLEAR / WRITE* selected. The remaining traces 2...4 are switched off (*BLANK*). For the split screen display, the selection of the trace automatically selects the corresponding screen for entry.

The *CLEAR/WRITE, MAX HOLD, MIN HOLD, AVERAGE, VIEW,* and *BLANK* are mutually exclusive selection switches.

The *CLEAR/WRITE* soft key activates the clear/write display mode.
The trace is displayed without additional trace evaluation. The trace memory is overwritten by each sweep. If more than one data point falls within a pixel, the trace is displayed in bar form with the maximum and minimum values in a pixel connected. In the clear/write display mode, all the available detectors are selectable. The autopeak detector is selected in the default mode (detector to *AUTO*).

After each *CLEAR/WRITE* soft key action, the FSE clears the selected trace memory and starts the measurement anew.

The *VIEW* soft key freezes the current contents of the trace memory and displays them on the display screen.

If the trace data were formed through *MAX HOLD, MIN HOLD* or *AVERAGE,* the trace can be continued, after switching to these trace modes, without clearing the trace contents. However, this is not possible if, in *VIEW,* the settings of the analyzer were changed (e.g., frequency, level, etc.).

If a trace is frozen by *VIEW,* the instrument settings can be modified without modifying the displayed trace. The fact that the trace and the current instrument setting do not agree anymore is indicated by an enhancement label "*" at the right edge of the grid. The initial instrument setting can be restored using the *ADJUST TO TRACE* soft key in the *TRACE MATH* sub-menu.

If LEVEL RANGE or REF LEVEL is changed in the *VIEW* display mode, the FSE adjusts the measurement data to the changed display range. Thus, an amplitude zoom can be performed after the measurement so that details of the trace can be seen better.

The *BLANK* softkey removes the trace from the display screen. However, the trace data remain stored in memory and can be displayed again by *VIEW*. The markers for the blanked trace are also erased. If the trace is activated again (with *VIEW, CLEAR / WRITE, MAX HOLD, MIN HOLD, AVERAGE*) the markers will be restored to their original positions.

The *AVERAGE* soft key enables the trace averaging function. The average is taken from several foregoing measurements. The average can be calculated for each available detector. In case the detector is automatically selected by the FSE , the sampling detector is chosen.

After enabling the averaging mode, the first trace is recorded in *CLEAR/WRITE* mode with the selected detector. After the second sweep, the average is then formed for each succeeding sweep. Here, the average is formed over the samples/pixels, i.e., according to the LIN or LOG setting, over amplitudes or levels.

The average always starts anew when one of the AVERAGE soft keys is pressed. The trace memory is also cleared. This is also the case when the trace is switched from the setting *AVERAGE* to *VIEW* or *BLANK*

Description of the averaging procedure:

Averaging is carried out using the pixels which are derived from the measurement value samples. These pixels may in some cases be comprised of several combined measurement values. This means that the average is formed over linear amplitude values when the level display is linear and over levels when the level display is logarithmic. Because of this, the trace must be measured anew when changing between the LIN and LOG display mode. The settings *CONT/SINGLE SWEEP* and the running average apply to the average display analogously.

Two calculation procedures are available for averaging. For *SWEEP COUNT*= 0 , a running average is calculated according to the following equation:

$$TRACE = \frac{9 * TRACE + MEAS\_VALUE}{10}$$

Because of the distribution of the weighting between the new measurement value and the trace average, the measurement history has essentially no influence on the displayed trace after around 10 sweeps have taken place. For this setting, the signal noise is effectively reduced without the need for restarting the averaging process even if the signal is changed.

If, for *SWEEP COUNT* a value >1 is entered, the averaging takes place over the selected number of sweeps. In this case, the displayed trace is determined according to the following equation:

$$TRACE = \frac{(n-1) * TRACE + MEAS\_VALUE}{n}$$

where n is the number of the current sweep (n = 2 ... average sweeps). For the first sweep, an average is not calculated. The measurement values are stored directly in trace memory. With growing n, the displayed trace is increasingly smoothed since more individual trace data are available for averaging.

The average trace is stored in trace memory after the defined number of sweeps. Until this number of sweeps is reached, a preliminary average is displayed.

In *SINGLE SWEEP* mode, *SWEEP START* initiates n single sweeps. The sweeps are stopped as soon as the selected number of sweeps is reached. The number of the current sweep and the total number of sweeps are shown in the display: "Sweep 3 of 200".

In *CONTINUOUS SWEEP* mode, the recording of data is continued even after reaching the maximum defined number of sweeps. Thus, values recorded earlier are given less and less weight. The display "Sweep 200 of 200" then remains constant until a new start is made.

The *SWEEP COUNT* soft key activates the entry of the number of sweeps, over which an average is to be calculated.
The permitted range for SWEEP COUNT is 0 through 32767. For 0, the FSE performs a running average over 10 sweeps. For 1, no averaging takes place.

The default setting is 10 sweeps. The programming naturally influences the sweep duration. The number of sweeps which are used in the averaging process or the averaging time are valid **for all 4 traces**.

Note : *The setting of the SWEEP COUNT in the trace menu is equivalent to the setting in the sweep menu.*

The *MAX HOLD* soft key activates the max hold mode.
In this display mode, the FSE saves for each sweep the largest of the previously stored/currently measured values in the trace memory. The detector is set automatically to *MAX PEAK*. In this way, the maximum value of a signal can be determined over several sweeps.

This is especially useful in the measurement of modulated or pulsed signals. The signal spectrum is filled at each sweep until all signal components have been captured.

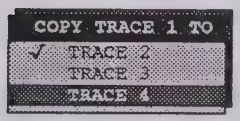
By pressing of the *MAX HOLD* soft key again, the trace memory is cleared and the maximum value accumulation begins anew.

If *MAX HOLD* is enabled, a new start is made after clearing the trace memory for each frequency change, (start frequency, stop frequency, center frequency or frequency span), a reference level change or switching between linear/logarithmic scales.

The *MIN HOLD* soft key activates the min hold mode.
In this display mode, the FSE saves for each sweep the smallest of the previously stored/currently measured values in the trace memory. The detector is set automatically to *MIN PEAK*. In this way, the minimum value of a signal can be determined over several sweeps. This function is, e.g., useful in making an unmodulated carrier in a mix of signals visible. Noise, interference signals or modulated signals are suppressed by the *MIN HOLD* function while a CW signal maintains a constant level.

Pressing the *MIN HOLD* soft key clears the trace memory and the minimum value function starts anew.

The *COPY* soft key copies the contents of the display screen for the current trace to another trace memory. A table appears in which the desired copy procedure can be selected.



For only one window, the selected trace can be copied to any of the other trace memories since here, all four traces are displayed in one diagram with the same frequency boundaries.
In the split screen display, this is only possible as long as the frequencies of screen A and screen B are identical. If this is not the case, the selected trace can only be copied to the corresponding trace memory, i.e., trace 1 to trace 3 and trace 2 to trace 4 or vice versa. In this case, only the available trace is displayed.

After copying, the contents of the destination memory are lost. The destination memory now changes automatically to view mode with the new data.

2.9.5.2 Detector Selection

The FSE detectors are realised by pure digital techniques . The detectors available are the max-peak detector which delivers the maximum value from a number of sample values, the min-peak detector which delivers the minimum value from a number of sample values and the sampling detector. The sampling detector can transfer the sampled data without modification or can perform a data reduction by suppressing non-displayable values. For the peak detectors, the current value is compared with the maximum/minimum levels of the previously sampled data. When the number of samples defined by the instrument settings is reached, the samples are collected into the available pixels. Thus, each of the 500 pixels of the display represents 1/500 of the sweep range and contains, in compressed form, all of the individual measurements (frequency samples) in this sub-range. Even though the recording rate is high, there are no recording gaps thanks to the internal pipeline structure. According to the trace display mode, an optimised detector is automatically applied. Since the peak detectors and the sample detector are connected in parallel, a single sweep is sufficient for recording and displaying four traces with four detectors.

Peak value detectors (*MAX PEAK / MIN PEAK*)

Peak value detectors are implemented by digital comparators. which determine the largest of all positive (max peak) or the smallest of all negative (min peak) peak values of the measured levels at the individual frequencies which are collectively displayed in one of the 500 pixels. This is repeated for each pixel so that, for wide frequency spans and inspite of the limited display resolution, a large number of measurements can be taken into consideration when displaying the spectrum.

Detector *AUTOPEAK*

The *AUTOPEAK* detector combines the two peak detectors. The max-peak detector and min-peak detector determine the maximum and minimum level at a displayed test point at the same time and display it as a common measurement value. The maximum and minimum level at a frequency point are joined up by means of a vertical line.

Detector *SAMPLE*

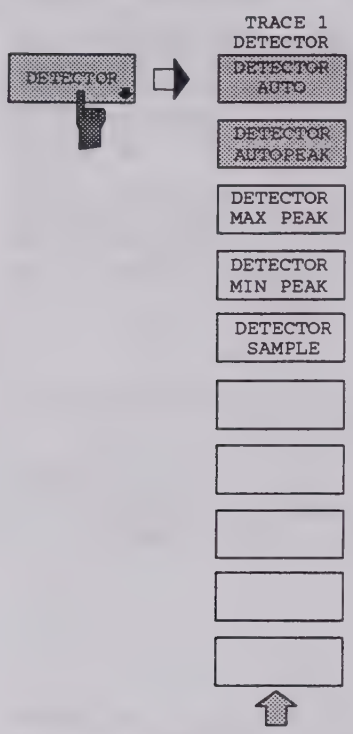
The *SAMPLE* detector transfers all sampled data without further evaluation and either displays them directly or, for reasons of speed (short sweep times), first writes them to memory and subsequently processes them.

Data reduction, i.e., a collection of measurement values for neighbouring frequencies or times is not performed here. If, during a sweep, more measurement values are generated than can be displayed, measurement values are lost. Discrete signals can thus be lost

Therefore, the sampling detector can only be recommended for a ratio of span-to-resolution bandwidth of up to approximately 250. This way, it can be guaranteed that no signal will be suppressed (example: span 1 MHz --> min. bandwidth 5 kHz).

Note: *During a sweep, the FSE advances the first oscillator in steps which are smaller than approximately 1/10 of the bandwidth. This guarantees that the level of a signal is correctly measured. For narrow bandwidths and wide spans, a very large number of measurement values are generated. The number of frequency steps is, however, always a multiple of 500 (= number of displayable points). In the sampling mode, only every n^{th} value is displayed. The quantity n depends upon the number of measurement values, i.e on the span, resolution bandwidth and the measurement rate.*

TRACE 1-DETECTOR submenu



The *DETECTOR* soft key opens a submenu to select the detector.

The detector type may be independently selected for each trace. Mode *DETECTOR AUTO* sets the best suitable detector for the type of trace display (Clear Write, Max Hold oder Min Hold).

The *DETECTOR AUTOPEAK*, *DETECTOR MAX PEAK*, *DETECTOR MIN PEAK* and *DETECTOR SAMPLE* soft keys are mutually exclusive selection switches.

The *DETECTOR AUTO* soft key(= default) selects the optimum detector dependent upon the trace mode (clear write, max hold, min hold).

Trace-mode	Detector
Clear/Write	Autopeak
Average	Sample
Max Hold	Max Peak
Min Hold	Min Peak

The *DETECTOR AUTOPEAK* soft key selects the autopeak detector.

The *DETECTOR MAX PEAK* soft key selects the max peak detector. It is recommended if pulse-shaped signals are to be measured.

The *DETECTOR MIN PEAK* soft key selects the min peak detector. Weak sinewave signals become clearly visible in noise by using this detector. For a composite signal made up of sinewave and pulse signals the pulse signals are suppressed.

The *DETECTOR SAMPLE* soft key selects the sample detector.

It is used if uncorrelated signals like noise are to be measured. The power can be determined by means of fixed correction factors for evaluation and the log amplifier.

2.9.5.3 Quasi Analog Display

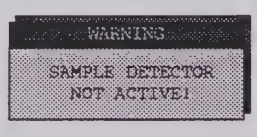
Normally, measurement points are displayed interconnected by a continuous line. The leads to a continuous curve which is erased and rewritten for each new sweep. However, in the domain of analog measurement technology, display screen persistence leads to statistical emphasis which is related to the relative frequency of occurrence of a signal. Thus, on the display screen, frequently occurring events appear much brighter than rarely occurring curve segments.

Using the *ANALOG TRACE* function, the characteristics of an analog display are simulated. In this case, a measurement value is displayed as a single pixel on the display screen. This pixel is reset only after a selectable number of sweeps or by explicitly clearing the trace with *CLEAR / WRITE*. The overwriting of several sweeps is now possible and a frequency-of-occurrence distribution of the measurement values can be observed.

TRACE 1 side menu

The ANALOG TR ON/OFF softkey enables/disables the *ANALOG TRACE* function for each trace.

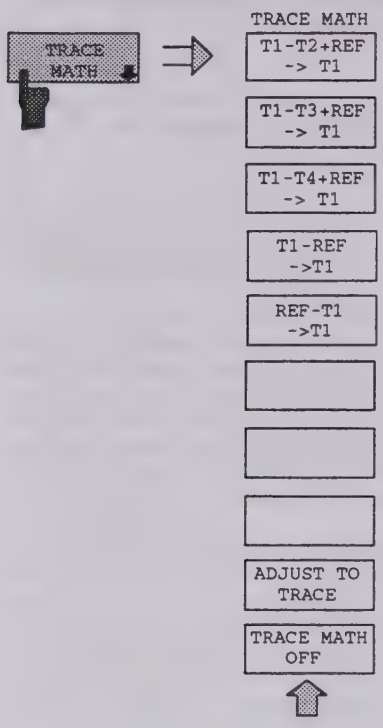
Normally, the measurement is made with the sampling detector. Should another detector be active when this function is turned on, the following message appears:



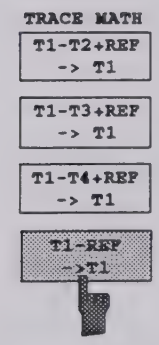
Pushing the CLR key deletes the message. The measurement is always made with the selected detector.

2.9.5.4 Mathematical Functions for Traces

TRACE 1-TRACE MATH submenu:



The *TRACE MATH* soft key opens a sub-menu in which a differential curve for the selected trace is calculated.



The *T1-T2+REF*, *T1-T3+REF*, *T1-T3+REF* and *T1-REF* soft keys subtract the corresponding traces and add the set level to the difference. If the reference line is switched on (see key D LINES), the level value of the reference line instead of the reference level is added to the difference. Thus, the differential curve can be positioned anywhere on the screen by shifting the reference line. The difference of the two traces with respect to the reference line is displayed.

To indicate that the trace has been obtained by a differential curve, a corresponding enhancement label is displayed at the right margin of the measurement value diagram (1-2, 1-3, 1-4, 1-R). In *TRACE 1* main menu, the *TRACE MATH* soft key is on a coloured background to show that the function is used.

Important: *For a display with two measurement windows, not all combinations are allowed if the sweep data for screen A and screen B are not the same. Only the traces allowed in the screen can be combined (in screen A, only trace 1 with trace 3; in screen B, only trace 2 with trace 4).*

The *REF - T1 -> T1* softkey provides an option for reflecting the stored trace about the reference line. The trace selected for this operation is set to *VIEW* before the calculation is performed.

If the reference line is disabled, the reflection takes place at the center of the grid.

The *TRACE MATH OFF* soft key switches the enabled differential curve off. The soft key is only available when a conversion function is enabled.

The *ADJUST TO TRACE* soft key restores the original instrument settings when the corresponding trace is set to *VIEW* and the current instrument settings are different than those of the trace data.

If a trace is frozen with *VIEW*, changes in the instrument settings can be made without influencing the trace. An asterisk(*) at the edge of the display screen indicates that the current instrument settings are different than those in effect when the trace was recorded. In this case, the *ADJUST TO TRACE* soft key is presented with which the original instrument setting can be restored.

2.9.6 Sweep Control – *SWEEP Key Group*

Using the *SWEEP* key group, the parameters are entered which determine the sweep characteristics. These are the coupled functions resolution bandwidth, video bandwidth and sweep time (*COUPLING* key), the trigger used for starting the sweep (*TRIGGER* key) and the type of sweep (*SWEEP* key).

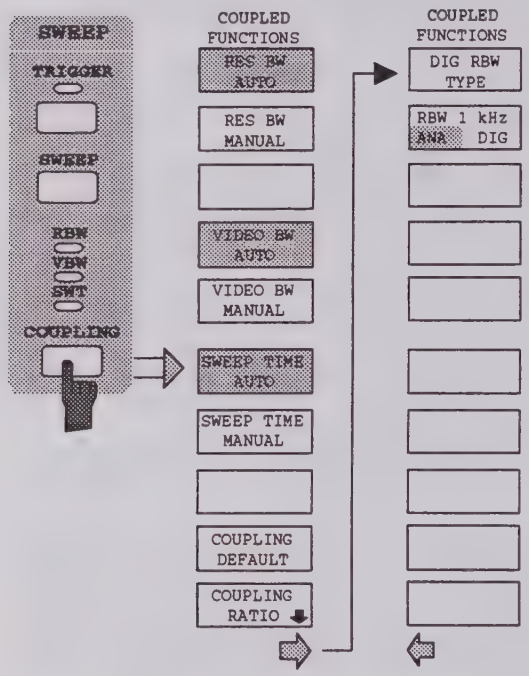
2.9.6.1 Coupled Settings – *COUPLING* Key

The *COUPLING* key calls a menu for entering the sweep parameters resolution bandwidth *(RBW)*, video bandwidth *(VBW)* and sweep time *(SWT)*. The parameters can be set dependent upon the span (stop - start frequency), coupled to each other or arbitrarily defined by the user. The entries for the split screen display mode are valid only for the active window.

The FSE resolution bandwidths between 10 Hz and 1 kHz have been implemented using digital filters with Gaussian characteristics. They behave like analog filters. The 1-kHz filter has been implemented both decoupled quartz filters and a digital filter. One of the two filter types can be selected. The bandwidths from 2 kHz to 50 kHz have been implemented using decoupled quartz filters, the bandwidths between 100 kHz and 5 MHz using decoupled LC filters. These filters consist of 4 circuits by model 20 and 5 circuits by model 30. The 10-MHz filter is a critically coupled LC filter.
For the bandwidths between 1 Hz and 1 kHz by model 20 with the option FSE-B5 and by model 30, FFT filtering can be alternatively selected. This allows for much faster run times compared to conventional filtering.
The video bandwidths are available in 1/2/3/5 steps between 1 Hz and 10 MHz. They can be set independent of the resolution bandwidth. Video bandwidths between 1 Hz and 10 kHz are available for bandwidths up to 1 kHz and video bandwidths between 1 Hz and 10 MHz are available for bandwidthsgreater than or equal to 2 kHz. The video filters are used to smooth the traces. Small video bandwidths in relation to the resolution bandwidth average out noise peaks pulse-like signals such that only the average value of the signals is displayed. A large video bandwidth in relation to the resolution bandwidth is therefore recommended when measuring pulsed signals (VBW ≥ 10 x RBW) so that the amplitude of pulses can be measured correctly.

2.9.6.1.1 Coupling Resolution / Video Bandwidth and Sweep Time

SWEEP COUPLING menu



The *COUPLING* key calls a menu and a supplementary menu for setting the resolution bandwidth, video bandwidth, sweep time and their coupling.

The various *AUTO* soft keys are used to couple the functions. The coupling ratios are selected in the *COUPLING RATIO* sub-menu.

The various *MANUAL* soft keys request that the respective parameter be entered in the entry window. This parameter is not coupled to the other parameters.

The *RES BW AUTO* soft key couples the resolution bandwidth to the selected span. Changing the span causes automatic compensation of the resolution bandwidth.

Automatic coupling of resolution bandwidth to span is always recommended when, for the measurement problem on hand, a favorable setting of the resolution bandwidth in relation to the selected span is desired.

The coupling ratio is set in the *COUPLING RATIO* sub-menu.

The coupling is indicated by illumination of the soft key and the active *RBW* LED.

The *RES BW AUTO* soft key is only available in the frequency domain (span > 0 Hz). The soft key is blanked in the time domain.

The *RES BW MANUAL* soft key activates the manual entry mode for the resolution bandwidth.

The resolution bandwidth of the FSEA20 or the FSEB20 can be set in 1/2/3/5 steps between 10 Hz and 10 MHz. The nominal resolution bandwidth is the 3-dB bandwidth. The lower bandwidth limit of the FSEA30 and FSEB30 or when the option FSE.B5 is installed is 1 Hz when the FFT filters are used. Otherwise, the smallest bandwidth is also 10 Hz.

For numerical inputs, the values are always rounded to the next valid bandwidth. For roll-key or the UP/DOWN key inputs, the bandwidth is adjusted in steps either upwards or downwards.

For manual input of the resolution bandwidth (coupling off), on the front panel remains off.

The *VIDEO BW AUTO* soft key couples the video bandwidth of the FSE to the resolution bandwidth. If the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

The coupling of the video bandwidth is always recommended when the maximum sweep time for a selected resolution bandwidth is to be achieved. Lower video bandwidths require longer sweep times due to the longer settling time. Wider bandwidths reduce the signal/noise ratio.

The coupling ratio is set in the *COUPLING RATIO* menu.

The coupling is indicated by illumination of the soft key and the lighted *VBW* LED on the front panel.

The coupling of the video bandwidth to the resolution filter is also permitted in the time domain (span = 0).

The *VIDEO BW MANUAL* soft key activates the manual input mode for the video bandwidth.

The video bandwidth is selectable in 1/2/3/5 steps between 1 Hz and 10 MHz. For bandwidths up to 1 kHz, the maximum video bandwidth is 10 kHz, for larger bandwidths, it is not limited.

For numerical inputs, rounding is made to the next possible bandwidth. For roll-key or UP/DOWN entries, the bandwidth is switched in steps either downwards or upwards.

For manual input, the video bandwidth (coupling disabled) *VBW* LED on the front panel is turned off.

The *SWEEP TIME AUTO* soft key couples the sweep time to the span, video bandwidth (VBW) and resolution bandwidth (RES BW). For a change in span, the resolution bandwidth or the video bandwidth is automatically matched to the sweep time. The FSE always selects the fastest sweep time which is possible without falsifying the level display.

The coupling is indicated by illumination of the soft key and turning on the *SWT* LED.

The soft key is only available in the frequency domain (span > 0 Hz). The soft key is blanked in the time domain.

The *SWEEP TIME MANUAL* soft key activates the manual input mode for the sweep time. At the same time, the coupling of the sweep is cancelled and the *SWT* LED is turned off. Other couplings (*VIDEO BW, RES BW*) remain in effect.

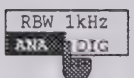
In the frequency domain (span > 0 Hz) and by resolution bandwidths ≥ 1 kHz, sweep times from 5 ms through 1000 s in steps not greater than 5% of the sweep time are allowed. The digital resolution filters from 10 Hz to 1 kHz allow a minimum sweep time of 20 ms. For displays in the time domain (span = 0 Hz), the range of sweep times 1 µs to 1000 s is selectable in steps not greater than 5% of the sweep time.

For numerical inputs, rounding is made to the next possible sweep time. For roll-key or UP/DOWN entries, the sweep time is switched in steps either downwards or upwards.

If the selected sweep time is too small for the selected span and bandwidth, measurement errors will occur. This happens because the available settling time for the resolution filter or the video filter is too short. In this case, the FSE outputs *UNCAL* on the display

The *COUPLING DEFAULT* soft key sets all coupled functions to to *AUTO*. In addition, the ratio *RBW / VBW* is set to *SINE [1]* and the ratio *SPAN/RBW* is set to 50 in the *COUPLING RATIO* sub-menu (default setting, *COUPLING RATIO* soft key not illuminated).

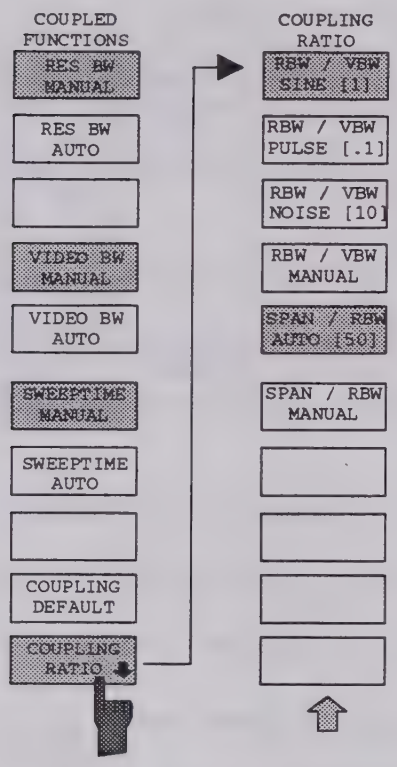
The relevant soft keys are then illuminated.



The *RBW 1 kHz ANA/DIG* soft key enables either the analog quartz filter (ANA) or the digital filter (DIG) for the FSE's resolution bandwidth of 1 kHz. In the default setting, the FSE uses the analog IF filter for the 1-kHz bandwidth.

2.9.6.1.2 Sweep Coupling Ratio

SWEEP COUPLING-COUPLING RATIO submenu:



The *COUPLING RATIO* soft key opens a sub-menu in which the coupling ratio between resolution bandwidth, video bandwidth and the span can be defined.

These settings are effective only for the selected parameters in ...*AUTO* of the main menu.

The soft keys *RBW / VBW PULSE, RBW / VBW SINEWAVE, RBW / VBW NOISE, RBW / VBW MANUAL* are selection keys. Only one soft key can be enabled (illuminated) at any one time.

The same is valid for the soft keys *SPAN / RWB AUTO [50]* and *SPAN / RWB MANUAL*.

The *RBW / VBW SINE [1]* soft key always sets the video bandwidth equal to the resolution bandwidth.

This is the default setting for the coupling ratio resolution bandwidth to video bandwidth.

This coupling ratio is recommended when sine-wave signals are to be measured.

This setting is only effective for the *VBW AUTO* selection in the main menu.

The *RBW / VBW PULSE* soft key sets the following coupling ratio:

video bandwidth = 10 x resolution bandwidth
or
video bandwidth = 5 MHz (= maximum video bandwidth).

This coupling ratio is always to be recommended when the amplitude of pulsed signal waveforms is to be measured. The IF filter characteristics alone determine the pulse shape. No additional weighting takes place via the video filter.

This setting is only effective for the *VBW AUTO* selection in the main menu.

The *RBW / VBW NOISE* soft key sets the following coupling ratio:
video bandwidth = resolution bandwidth/10

With this setting, noise and pulsed signals are suppressed in the video section. For noise signals, the FSE displays the average value.

This setting is only effective for the *VBW AUTO* selection in the main menu.

The *RBW / VBW MANUAL* soft key activates the coupling ratio for resolution bandwidth to video bandwidth.

The ratio of resolution bandwidth to video bandwidth can be set in the range from 0,001 to 1000.

This setting is only effective for the *VBW AUTO* selection in the main menu.

The *SPAN / RBW AUTO [50]* soft key sets the following coupling:
resolution bandwidth = span/50

This coupling corresponds to the default state.

This setting is only effective for the *RBW AUTO* selection in the main menu.

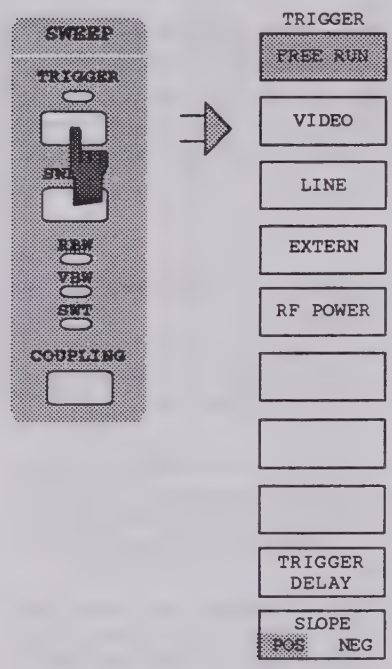
The *SPAN / RBW MANUAL* soft key activates the manual entry mode for the coupling of resolution bandwidth and span.

The ratio of resolution bandwidth to span can be in the range from 1 to 10000.

This setting is only effective for the *RBW AUTO* selection in the main menu.

2.9.6.2 Sweep Trigger – *TRIGGER Key*

SWEEP TRIGGER menu:



The *TRIGGER* key opens a menu for selection of the various trigger sources and the trigger polarity. The active trigger mode is indicated by illumination of the corresponding soft key.

For triggering modes in which the trigger threshold can be entered, the corresponding entry window is activated and, if appropriate, a horizontal trigger line is displayed.

The *FREE RUN, VIDEO, LINE, EXTERN* and *RF-POWER* soft keys are selection switches. Only one key can be enabled at any one time (illuminated). For sweep operations with an external gate the *FREE RUN* setting is the only setting possible.

If triggering has taken place, the trigger LED is turned on at the beginning of the sweep and then turned off at the end of sweep.

The *FREE RUN* soft key activates the free-run sweep mode (default setting).

In free-run sweep mode there is no triggering at the start of sweep.

The *VIDEO* soft key activates triggering by the displayed voltage.

For the video triggering mode, a level line showing the trigger threshold is displayed. Using the level line, the threshold can be adjusted with the roll-key or the UP/DOWN keys.

The *LINE* soft key activates triggering derived from the mains (line) frequency. The power supply generates a trigger pulse at the line frequency which is used to trigger a new sweep.

The *EXTERN* soft key activates triggering via an external voltage (-5V...+5V) at the input connector *EXT TRIGGER/GATE* on the rear panel.

The trigger threshold can be set in an entry window within a range of -5V...+5V.

External triggering in the sweep mode external gate (*SWEEP SWEEP-EXT GATE ON)* is not possible. The soft key is not illuminated in these modes.

To indicate that the FSE is set for external triggering, the enhancment label **TRG** is shown on the display. If two measurement windows are displayed, TRG appears next to the window which is configured for external triggering.

The *RF POWER* soft key activates triggering of the measurement via signals which are outside the measurement channel.

The FSE uses a level detector at the intermediate frequency. The detector threshold is approximately -4 dBm at the input mixer. This means that the actual trigger level at the RF input is approx. -4 dBm plus the set RF attenuation.

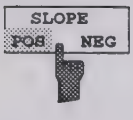
The bandwidth at the intermediate frequency is approximately 100 MHz. Triggering takes place when the trigger threshold is exceeded within a 100 MHz bandwidth about the selected frequency. Thus, the measurement of noise emissions, e.g., for pulsed carriers, is possible. The carrier itself is suppressed via the selected resolution filter.

To indicate that the FSE is set for RF power triggering, the enhancment label **TRG** is shown on the display. If two measurement windows are displayed, TRG appears next to the window which is configured for RF power triggering.

The *TRIGGER DELAY* soft key activates the entry window for delay time.

The triggering is delayed by the entered delay time. The delay time can be set in the range from 1 µs to 100 s (default = 0 s).

Note: *For measurements in the time domain (span = 0 Hz), a pretrigger time can also be set for the GAP SWEEP mode.*



The *SLOPE POS/NEG* soft key selects the trigger slope.

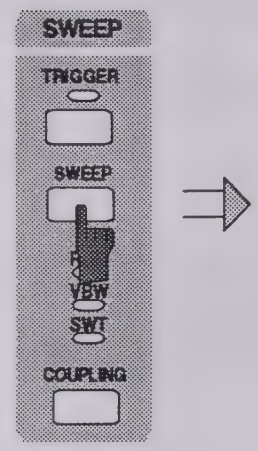
The sweep starts after a positive or negative edge of the trigger signal. The selected setting is illuminated.

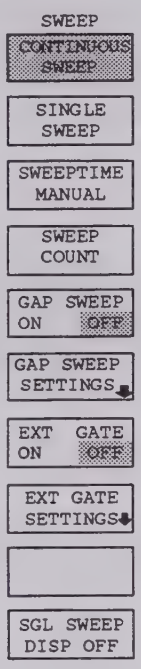
The selection is valid for all trigger modes with the exception of *FREE RUN.*

The default mode is *SLOPE POS.*

2.9.6.3 Sweep Setup – *SWEEP* Key

SWEEP SWEEP menu:





The *SWEEP* key calls a menu in which the type of sweep (sweep mode) is determined. In split screen mode, the entries are valid only for the active measurement window.

In the menu, continuous or single sweep mode, gap-sweep settings or the external gate function can be selected.

The *CONTINUOUS SWEEP* and *SINGLE SWEEP* soft keys are selection switches. Only one soft key can be active (illuminated) at any one time.

The *CONTINUOUS SWEEP* soft key sets the continuous sweep mode. This means, that the sweep takes place continuously according to the trigger conditions.

In case of split screen display with different settings in each measurement window, screen A is swept first and then screen B. After pressing the soft key, the sweep is initialised and restarted.

CONTINUOUS SWEEP is the default setting of the FSE.

The *SINGLE SWEEP* soft key starts a series of n sweeps according to the triggering definition. The number of sweeps, n, is determined by the *SWEEP COUNT* soft key.

In split screen display mode, the spans of each window are swept sequentially. If a displayed curve is averaged, the span is swept n times (n = sweep count). For n = 0, a single sweep takes place.

The *SWEEPTIME MANUAL* soft key activates the manual input mode for the sweep time. This function is identical to the function of the same name in the *COUPLING* sub-menu (see section 2.9.6.1.1).

The *SGL SWEEP DISP OFF* soft key switches off the display during a single sweep. The trace is displayed when the sweep has terminated.

The *SWEEP COUNT* soft key activates the entry window for setting the number of sweeps over which video averaging is to take place, or the number of *SINGLE SWEEP*s which are to be performed.

The permissible range for the sweep count is 0 througn 32767. When 0, the FSE performs a runnung average over 10 sweeps in average mode. When 1, no averaging takes place.

The default setting totals 10 sweeps. The number of sweeps and the averaging time used are applied to all four measurement curves.

Note: *The setting for the number of sweeps in the TRACE menu is equivalent to the setting in the SWEEP menu. In SINGLE SWEEP mode, the measurement is stopped after reaching the chosen number of sweeps.*

2.9.6.3.1 Sweep Mode with External Gate

By using an external gate in sweep mode and stopping the measurement while the gate signal is inactive, the spectrum for pulsed carriers can be displayed without overlaid frequency components caused by the on/off switching procedure. Similarly, the spectrum can also be examined for an inactive carrier.

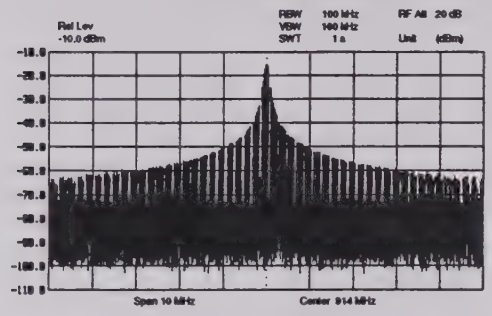


Fig. 2.9-5 Pulsed signal EXT GATE OFF

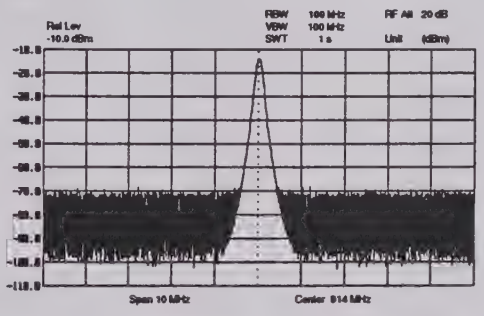


Fig 2.9-6 Signal with EXT GATE ON

The *EXTERNAL GATE* mode is activated by the *EXT GATE ON/OFF* soft key. The setting of the mode takes place in the *EXT GATE SETTINGS* sub-menu.

SWEEP SWEEP menu:

The *EXT GATE ON / OFF* soft key switches the sweep mode with an external gate on/off.

When *EXT GATE ON* is selected, a signal applied to the rear panel connector *EXT TRIGGER/GATE* controls the sweep of the analyzer. The sweep can be stopped and then continued. A switch from an edge triggered to a level triggered mode can also be made.

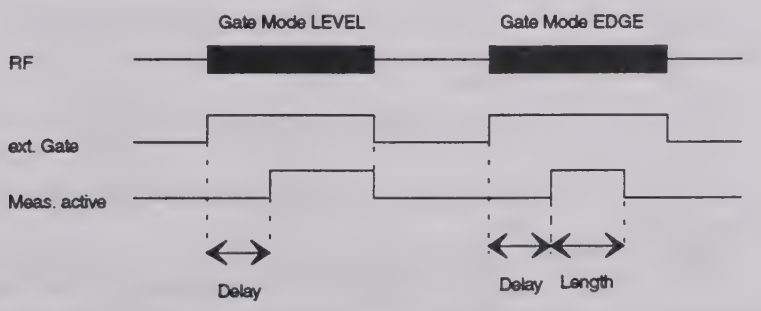


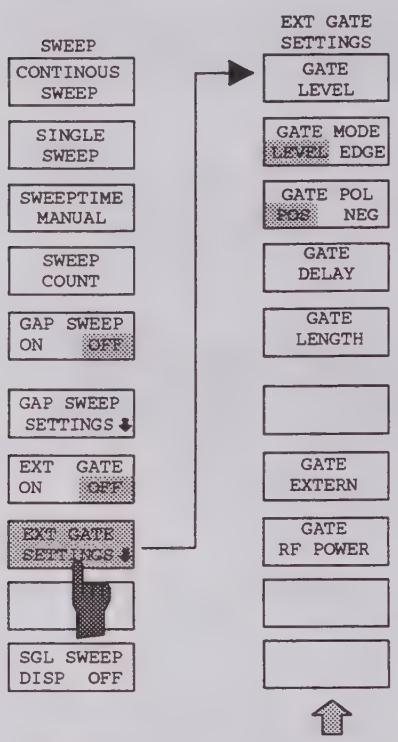
Fig. 2.9-7 Interaction of the parameters *GATE MODE*, *GATE DELAY* and *GATE LENGTH*

The soft key is only available in the frequency domain (span > 0).

EXT GATE ON is only possible when the trigger mode is set to *FREE RUN* (*SWEEP TRIGGER* menu) .

To indicate that the is set for sweep mode with external gate, the enhancment label GAT is shown on the display. GAT appears next to the window which is configured for sweep mode with external gate.

SWEEP SWEEP-EXT GATE SETTINGS sub-menu:



In the *EXT GATE SETTINGS* sub-menu, all settings are made which are necessary for operation with an external gate.

In the time domain, the *GATE DELAY* and *GATE LENGTH* times are displayed by time lines which allow simple adjustment of the gate time.

The *GATE LEVEL* soft key activates the entry window for defining the threshold value of the external gate signal.

The threshold can be set between -5V and +5V.

The *GATE MODE LEVEL/EDGE* soft key selects the trigger mode. The sweep mode *EXT GATE* can be operated either as level or as edge triggered.

For level triggering, the *GATE LENGTH* soft key is not activated.

The *GATE POL* soft key determines the polarity of the *EXT GATE* control line.

If level triggering with *GATE POL POS* is set, the sweep is stopped when the gate signal is a logic ' 0 ' (input signal < gate level) at the *TRIGGER/EXT GATE* input and then, when the gate signal goes to a logic ' 1 ', the sweep is continued after a delay time of *GATE DELAY*.

For edge triggering and a change from ' 0 ' to ' 1 ', i.e., the positive edge of the *EXT TRIGGER/GATE* input signal, the sweep is continued after a delay of *GATE DELAY* for a duration which was set by the *GATE LENGTH* soft key.

The *GATE DELAY* soft key activates the entry window for setting the delay time between the external gate signal and the continuation of the sweep.

Thus, e.g., delays between the gate signal and the stabilisation of an RF carrier can be taken into consideration.

For the gate delay time, values can be selected between 1 µs and 100 s in 1/2/3/5 steps. The resolution is dependent upon the absolute value of the delay time:

Gate delay	Resolution
0 - 500 µs	1 µs
0.5 - 5 ms	5 µs
5 - 50 ms	50 µs
50 - 500 ms	500 µs
0.5 - 5 s	5 ms
5 - 50 s	50 ms
50 - 100 s	500 ms

In the time domain, a time line is displayed separated from the trigger point by the gate delay time. This simplifies the adjustment of the necessary delay time.

The values for *GATE DELAY* and *GATE LENGTH* are displayed by two time lines. The duration of the active sweep for span > 0 (continuation of sweep: GATE DELAY line, stopping of sweep: GATE LENGTH line) is described by these two lines. A change in parameters causes a shift of the corresponding line position. After switching to span > 0, the selected times for the gated sweep are effective.

For edge triggering, the *GATE LENGTH* soft key activates the entry window for defining the FSE sweep duration.

GATE LENGTH can be set to values between 1µs and 100 s in 1/2/3/5 steps. The resolution is dependent upon the absolute value of the gate length:

Gate length	Resolution
0 - 500 µs	1 µs
0.5 - 5 ms	5 µs
5 - 50 ms	50 µs
50 - 500 ms	500 µs
0.5 - 5 s	5 ms
5 - 50 s	50 ms
50 - 100 s	500 ms

In the time domain, a time line is displayed separated from the *GATE DELAY* time by the *GATE LENGTH* time.

The soft key is only available for the *GATE MODE EDGE* setting (edge triggering). It is disabled for the *GATE MODE LEVEL* setting (level triggering).

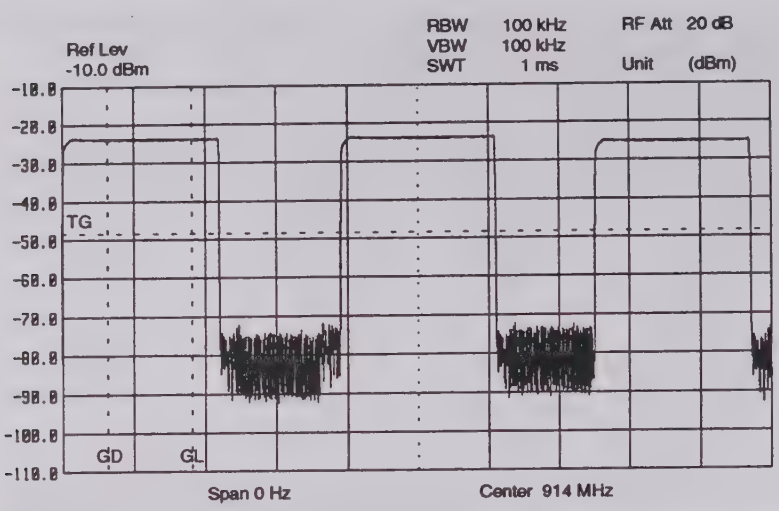


Fig. 2.9-8 Setting the GATE DELAY and GATE LENGTH times in the time domain using the GD and GL lines.

The *GATE EXTERN* and *GATE RF POWER*. soft keys are mutually exclusive selection switches. Only one switch can be active at any one time:

The *GATE EXTERN* soft key selects the external trigger as gate source.

The *GATE RF POWER* soft key selects the RF power detector as gate source.

2.9.6.3.2 Sweep Blanking – Gap Sweep

For measurements in the time domain, the *GAP SWEEP* function offers a high degree of flexibility with regard to the display of measurement data. With the *PRE TRIGGER* soft key, it is possible to display measurements taken before the trigger time. With the *GAP TIME* soft key, the measurements within a predefined time range can be blanked. Thus, it is possible to display the rising and falling edge of a signal with high resolution on a single diagram.

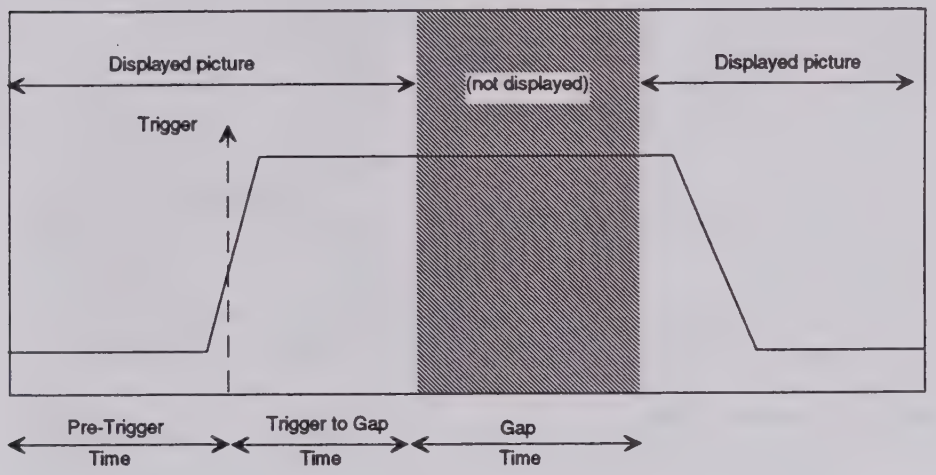


Fig 2.9-9 Trace blanking in sweep mode.– Gap Sweep

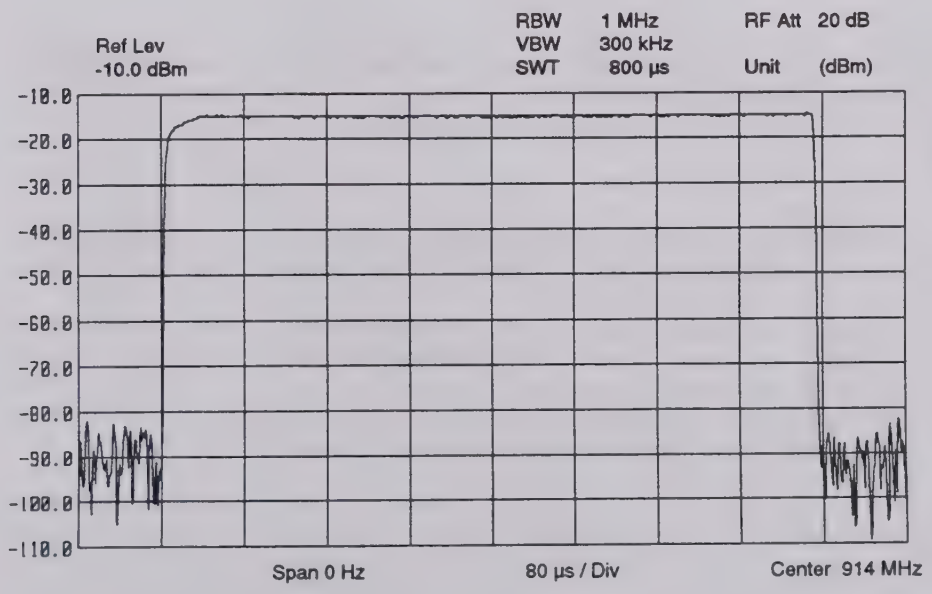


Fig. 2.9-10 Display of a burst without gaps.

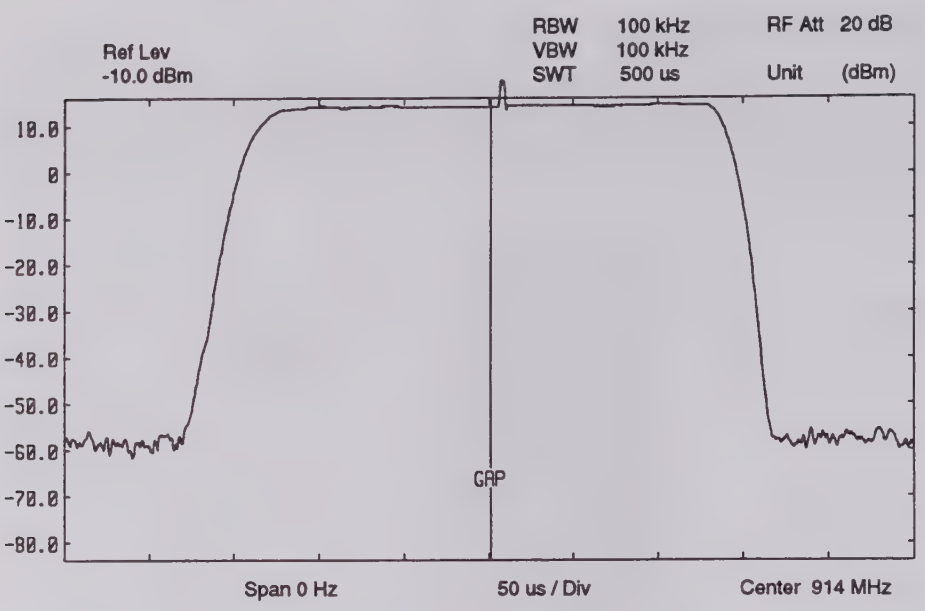


Fig. 2.9-11 Display of a burst with a gap

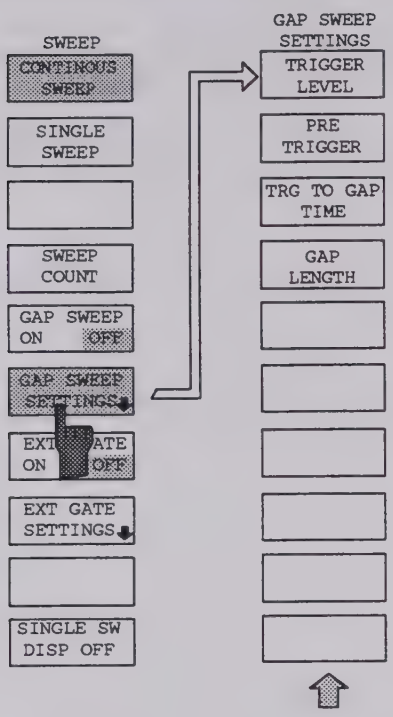
The GAP SWEEP measurement is activated by the GAP SWEEP *ON/OFF* soft key. The mode settings are made in the GAP SWEEP *SETTINGS* sub-menu.

SWEEP SWEEP menu:

The *GAP SWEEP ON/OFF* soft key switches the *GAP SWEEP* measurement on/off.

The soft key is available only in the time domain.

SWEEP SWEEP-GAP SWEEP SETTINGS sub-menu:



The *GAP SWEEP SETTINGS* soft key opens a sub-menu in which the parameters for the gap can be selected.

When the *GAP SETTINGS* sub-menu is called in the time domain, the trigger level and the time of trigger are marked by a horizontal/vertical line respectively. The lines are disabled upon leaving the menu.

The trigger time corresponds to t = 0. Events occurring before the trigger time are displayed in negative time.

The *TRIGGER LEVEL* soft key activates the entry window for trigger level.

This function corresponds to the setting in the trigger menu.

The *PRE TRIGGER* soft key activates the entry window for the pre-trigger time. The pre-trigger time defines the separation between the left edge of the grid and the trigger time (t = 0).

The pre-trigger can be set in the range from 0 µs through 100 s with a maximum resolution of 50 ns.

The *PRE TRIGGER* value can be entered in the frequency domain (span > 0) as well as in the time domain and *GAP SWEEP OFF* mode. It is, however, only effective when the *GAP SWEEP* measurement is enabled.

The *TRG TO GAP TIME* soft key opens an entry window for defining the distance between the trigger time and the beginning of the gap.

The *TRIGGER TO GAP TIME* range is from 0 to 100 s with a resolution of 50 ns. The length of the gap is defined by *GAP LENGTH*. If the *GAP LENGTH* is 0 s, the entered value of *TRG TO GAP TIME* is only stored.

The *TRG TO GAP TIME* value can be entered in the frequency domain (span > 0) as well as in the time domain and for the *GAP SWEEP OFF* mode. It has an effect on the measurement only after the *GAP SWEEP ON* is switched on.

The *GAP LENGTH* soft key activates the entry window for defining the gap within which the measurement values are to be blanked.

The beginning of the gap is defined by *TRG TO GAP TIME*.

GAP LENGTH can be set to values between 150 ns and 100 s in 1/2/3/5 steps. The resolution is dependent upon the absolute value of the gap length:

Gap length	Resolution
150 ns - 50 µs	50 ns
50 - 500 µs	500 ns
0.5 - 5 ms	5 µs
5 - 50 ms	50 µs
50 - 500 ms	500 µs
0.5 - 5 s	5 ms
5 - 50 s	50 ms
50 - 100 s	500 ms

The *GAP LENGTH* value can be entered in the frequency domain (span > 0) as well as in the time domain and for the *GAP SWEEP OFF* mode. It has an effect on the measurement only after the *GAP SWEEP ON* is switched on.

3 Remote Control

3.1 Introduction

The instrument is equipped with an IEC-bus interface according to standard IEC 625.1/IEEE 488.2 and two RS-232 interfaces. The connectors are located at the rear of the instrument and permits to connect a controller for remote control.

The option FSE-B15 (controller function) together with the option FSE-B17 (2nd IEC-bus interface) may also be used as a controller (see Chapter 1, Section 1.9).

The instrument supports the SCPI version 1994.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers (see Section "SCPI Introduction").

This section assumes basic knowledge of IEC-bus programming and operation of the controller. A description of the interface commands is to be obtained from the relevant manuals.

The requirements of the SCPI standard placed on command syntax, error handling and configuration of the status registers are explained in detail in the respective sections. Tables provide a fast overview of the commands implemented in the instrument and the bit assignment in the status registers. The tables are supplemented by a comprehensive description of every command and the status registers. Detailed program examples of the main functions are to be found in annex D.

The program examples for IEC-bus programming are all written in Quick BASIC.

3.2 Brief Instructions

The short and simple operating sequence given below permits fast putting into operation of the instrument and setting of its basic functions. As a prerequisite, the IEC-bus address, which is factory-set to 20, must not have been changed.

1. Connect instrument and controller using IEC-bus cable.
2. Write and start the following program on the controller:

```
CALL IBFIND("DEV1", analyzer%)                    'Open port to the instrument
CALL IBPAD(analyzer%, 20)                         'Inform controller about instrument
                                                  'address
CALL IBWRT(analyzer%, "*RST;*CLS")                'Reset instrument
CALL IBWRT(analyzer%, "FREQ:CENT 100MHz")         'Set center frequency to 100 MHz
CALL IBWRT(analyzer%, "FREQ:SPAN 10MHz")          'Set span to 10 MHz
CALL IBWRT(analyzer%, "DISP:TRAC:Y:RLEV -10dBm")  'Set reference level to -10 dBm
```

The instrument now performs a sweep in the frequency range of 95 MHz to 105 MHz.

3. To return to manual control, press the *LOCAL* key at the front panel

This page is intentionally left blank.

3.3 Switchover to Remote Control

On power-on, the instrument is always in the manual operating state ("LOCAL" state) and can be operated via the front panel.
It is switched to remote control ("REMOTE" state)

IEC-bus as soon as it receives an addressed command from a controller.

RS-232 as soon as it receives the command "@REM" from a controller.

During remote control, operation via the front panel is disabled. The instrument remains in the remote state until it is reset to the manual state via the front panel or via remote control interfaces. Switching from manual operation to remote control and vice versa does not affect the remaining instrument settings.

3.3.1 Remote Control via IEC Bus

3.3.1.1 Setting the Device Address

In order to operate the instrument via the IEC-bus, it must be addressed using the set IEC-bus address. The IEC-bus address of the instrument is factory-set to 20. It can be changed manually in the *SETUP - GENERAL SETUP* menu or via IEC bus. Addresses 0 to 30 are permissible.

Manuell:

- ➢ Call *SETUP - GENERAL SETUP* menu
- ➢ Enter desired address in table *GPIB ADDRESS*
- ➢ Terminate input using one of the unit keys (=ENTER).

Via IEC bus:

```
CALL IBFIND("DEV1", analyzer%)                    'Open port to the instrument
CALL IBPAD(analyzer%, 20)                         'Inform controller about old address
CALL IBWRT(analyzer%, "SYST:COMM:GPIB:ADDR 18")   'Set instrument to new address
CALL IBPAD(analyzer%, 18)                         'Inform controller about new address
```

3.3.1.2 Indications during Remote Control

Remote control mode is indicated by the LED "REMOTE" on the instrument's front panel. In this mode the softkeys on the display are not shown.

3.3.1.3 Return to Manual Operation

Return to manual operation is possible via the front panel or the IEC bus.

Manually:

➢ Press the *LOCAL* key.

Notes:

- *Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.*
- *The LOCAL key can be disabled by the universal command LLO (see annex A) in order to prevent unintentional switchover. In this case, switchover to manual mode is only possible via the IEC bus.*
- *The LOCAL key can be enabled again by deactivating the REN line of the IEC bus (see annex A).*

Via IEC bus:

```
...
CALL IBLOC(analyzer%)          'Set instrument to manual operation.
...
```

3.3.2 Remote Control via RS-232-Interface

3.3.2.1 Setting the Transmission Parameters

To enable an error-free and correct data transmission, the parameters of the unit and the controller should have the same setting. Parameters can be manually changed in menu *SETUP-GENERAL SETUP* in table *COM PORT 1/2* or via remote control using the command `SYSTem:COMMunicate:SERial1|2:....`

The transmission parameters of the interfaces COM1 and COM2 are factory-set to the following values: baudrate = 9600, data bits = 8, stop bits = 1, parity = NONE and protocoll = NONE.

Manually: Setting interface COM1|2

- ➢ Call *SETUP-GENERAL SETUP* menu
- ➢ Select desired baudrate, bits, stopbit, parity and protocoll in table *COM PORT 1/2*.
- ➢ Terminate input using one of the unit keys (=ENTER).

3.3.2.2 Indications during Remote Control

See Section 3.3.1.2.

3.3.2.3 Return to Manual Operation

Return to manual operation is possible via the front panel or via RS-232 interface.

Manually: ➢ Press the *LOCAL* key.

Note:
- *Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.*
- *The LOCAL key can be disabled by the universal command LLO (see annex A) in order to prevent unintentional switchover. In this case, switchover to manual mode is only possible via the IEC bus.*
- *The LOCAL key can be enabled again by sending the command "@LOC" via RS-232 (see annex A).*

Via RS-232:

```
...
V24puts(port, "@LOC");
...
```

Set instrument to manual operation.

This page is intentionally left blank.

3.4 IEC-Bus Messages

The messages transferred via the data lines of the IEC bus (see annex A) can be divided into two groups:

- **interface messages and**
- **device messages.**

For the RS-232 interface, no interface messages are defined.

3.4.1 Interface Messages

Interface messages are transferred on the data lines of the IEC bus, the "ATN" control line being active. They are used for communication between controller and instrument and can only be sent by a controller which has the IEC-bus control. Interface commands can be subdivided into

- **universal commands and**
- **addressed commands.**

Universal commands act on all devices connected to the IEC bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in annex A.

Some control characters are defined for the control of the RS-232-interface (see annex A).

3.4.2 Device Messages (Commands and Device Responses)

Device messages are transferred on the data lines of the IEC bus, the "ATN" control line not being active. ASCII code is used. The device messages are more or less equal for the 2 interfaces (IEC-bus and RS-232).
A distinction is made according to the direction in which they are sent on the IEC bus:

- **Commands** are messages the controller sends to the instrument. They operate the device functions and request informations.
  The commands are subdivided according to two criteria::

  1. According to the effect they have on the instrument:

     Setting commands cause instrument settings such as reset of the instrument or setting the center frequency.

     Queries cause data to be provided for output on the IEC-bus, e.g. for identification of the device or polling the marker.

  2. According to their definition in standard IEEE 488.2:

     Common Commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as management of the standar-dized status registers, reset and selftest.

     Device-specific commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standardized by the SCPI committee (cf. Section 3.5.1).

- **Device responses** are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status (cf. Section 3.5.4).

Structure and syntax of the device messages are described in Section 3.5. The commands are listed and explained in detail in Section 3.6.

3.5 Structure and Syntax of the Device Messages

3.5.1 SCPI Introduction

SCPI (Standard Commands for Programmable Instruments) describes a standard command set for programming instruments, irrespective of the type of instrument or manufacturer. The goal of the SCPI consortium is to standardize the device-specific commands to a large extent. For this purpose, a model was developed which defines the same functions inside a device or for different devices. Command systems were generated which are assigned to these functions. Thus it is possible to address the same functions with identical commands. The command systems are of a hierarchical structure.
Fig. 3.5-1 illustrates this tree structure using a section of command system SOURce, which operates the signal sources of the devices. The other examples concerning syntax and structure of the commands are derived from this command system.
SCPI is based on standard IEEE 488.2, i.e. it uses the same syntactic basic elements as well as the common commands defined in this standard. Part of the syntax of the device responses is defined with greater restrictions than in standard IEEE 488.2 (see Section "Responses to Queries").

3.5.2 Structure of a Command

The commands consist of a so-called header and, in most cases, one or more parameters. Header and parameter are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several key words. Queries are formed by directly appending a question mark to the header.

Note: *The commands used in the following examples are not in every case implemented in the instrument.*

Common commands

Common commands consist of a header preceded by an asterisk "*" and one or several parameters, if any.

Examples:

`*RST`	RESET, resets the device
`*ESE 253`	EVENT STATUS ENABLE, sets the bits of the event status enable register
`*ESR?`	EVENT STATUS QUERY, queries the contents of the event status register.

Device-specific commands

Hierarchy: Device-specific commands are of hierarchical structure (see Fig. 3.5-1). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system.

Example: `SENSe` This key word denotes the command system `SENSe`.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example: `SENSe:FREQuency:SPAN:LINK STARt`

This command lies in the fourth level of the SENSe system. It determines which parameter remains unchanged when the span is changed. If LINK is set to STARt, the values of CENTer and STOP are adjusted when the span is changed.

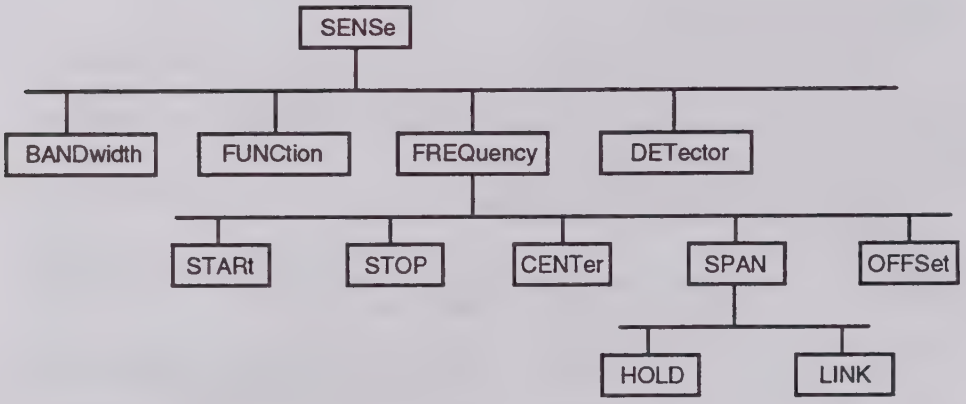


Fig. 3.5-1 Tree structure the SCPI command systems using the SENSe system by way of example

Some key words occur in several levels within one command system. Their effect depends on the structure of the command, that is to say, at which position in the header of a command they are inserted.

Example: `SOURce:FM:POLarity NORMal`
This command contains key word POLarity in the third command level. It defines the polarity between modulator and modulation signal.

`SOURce:FM:EXTernal:POLarity NORMal`
This command contains key word POLarity in the fourth command level. It defines the polarity between modulation voltage and the resulting direction of the modulation only for the external signal source indicated.

Optional key words: Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked by square brackets in the description. The full command length must be recognized by the instrument for reasons of compatibility with the SCPI standard. Some commands are considerably shortened by these optional key words.

Example: `[SENSe]:BANDwidth[:RESolution]:AUTO`
This command couples the resolution bandwidth of the instrument to other parameters. The following command has the same effect:
`BANDwidth:AUTO`

Note: *An optional key word must not be omitted if its effect is specified in detail by a numeric suffix.*

Long and short form: The key words feature a long form and a short form. Either the short form or the long form can be entered, other abbreviations are not permissible.

Beispiel: `STATus:QUEStionable:ENABle 1= STAT:QUES:ENAB 1`

Note: *The short form is marked by upper-case letters, the long form corresponds to the complete word. Upper-case and lower-case notation only serve the above purpose, the instrument itself does not make any difference between upper-case and lower-case letters.*

Parameter: The parameter must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma ",". A few queries permit the parameters MINimum, MAXimum and DEFault to be entered. For a description of the types of parameter, refer to Section 3.5.5.

Example: `SENSe:FREQuency:STOP? MAXimum` Response: 3.5E9
This query requests the maximal value for the stop frequency.

Numeric suffix: If a device features several functions or features of the same kind, e.g. inputs, the desired function can be selected by a suffix added to the command. Entries without suffix are interpreted like entries with the suffix 1.

Example:. `SYSTem:COMMunicate:SERial2:BAUD 9600`
This command sets the baudrate of the second serial interface.

3.5.3 Structure of a Command Line

A command line may consist of one or several commands. It is terminated by a <New Line>, a <New Line> with EOI or an EOI together with the last data byte. Quick BASIC automatically produces an EOI together with the last data byte.

Several commands in a command line are separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:
```
CALL IBWRT(analyzer%, "SENSe:FREQuency:CENTer 100MHz;:INPut:ATTenuation 10")
```

This command line contains two commands. The first command is part of the SENSe system and is used to specify the center frequency of the analyzer. The second command is part of the INPut system and sets the attenuation of the input signal.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels (see also Fig. 3.5-1). The colon following the semicolon must be omitted in this case.

Example:
```
CALL IBWRT(analyzer%, "SENSe:FREQuency:STARt 1E6;:SENSe:FREQuency:STOP 1E9")
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the SENSe command system, subsystem FREQuency, i.e. they have two common levels.
When abbreviating the command line, the second command begins with the level below SENSe:FREQuency. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

```
CALL IBWRT(analyzer%, "SENSe:FREQuency:STARt 1E6;STOP 1E9")
```

However, a new command line always begins with the complete path.

Example:
```
CALL IBWRT(analyzer%, "SENSe:FREQuency:STARt 1E6")
CALL IBWRT(analyzer%, "SENSe:FREQuency:STOP 1E9")
```

3.5.4 Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

1 The requested parameter is transmitted without header.
Example: `INPut:COUPling?` Response: `DC`

2. Maximum values, minimum values and all further quantities, which are requested via a special text parameter are returned as numerical values.
Example: `SENSe:FREQuency:STOP? MAX` Response: `3.5E9`

3. Numerical values are output without a unit. Physical quantities are referred to the basic units or to the units set using the Unit command.
Example: `SENSe:FREQuency:CENTer?` Response: `1E6` for 1 MHz

4. Truth values <Boolean values> are returned as 0 (for OFF) and 1 (for ON).
Example: `SENSe:BANDwidth:AUTO?` Response: `1` for ON

5. Text (character data) is returned in a short form (see also Section 3.5.5).
Example: `SYSTem:COMMunicate:SERial:CONTrol:RTS?` Response(for standard): `STAN`

3.5.5 Parameter

Most commands require a parameter to be specified. The parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The type of parameter required for the respective command and the permissible range of values are specified in the command description (see Section 3.6).

Numerical values

Numerical values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not permissible. In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega), MOHM and MHZ are also permissible), K (kilo), M (milli), U (micro) and N (nano). It the unit is missing, the basic unit is used.

Example:
`SENSe:FREQuency:STOP 1.5GHz = SENSe:FREQuency:STOP 1.5E9`

Special numerical

The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as valuesspecial numerical values.

In the case of a query, the numerical value is provided.

Example: Setting command: `SENSe:FREQuency:STOP MAXimum`
Query: `SENSe:FREQuency:STOP?` Response: `3.5E9`

MIN/MAX — MINimum and MAXimum denote the minimum and maximum value.

DEF — DEFault denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the *RST command

UP/DOWN — UP, DOWN increases or reduces the numerical value by one step. The step width can be specified via an allocated step command (see annex C, List of Commands) for each parameter which can be set via UP, DOWN.

INF/NINF — INFinity, Negative INFinity (NINF) Negative INFinity (NINF) represent the numerical values -9.9E37 or 9.9E37, respectively. INF and NINF are only sent as device reponses.

NAN — Not A Number (NAN) represents the value 9.91E37. NAN is only sent as device response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Boolean Parameters — Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. 0 or 1 is provided in a query.

Example: Setting command: `DISPlay:WINDow:STATe ON`
Query: `DISPlay:WINDow:STATe?` Response: `1`

Text

Text parameters observe the syntactic rules for key words, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example: Setting command: `INPut:COUPling GROund`
Query: `INPut:COUPling?` Response `GRO`

Strings

Strings must always be entered in quotation marks (' or ").

Example: `SYSTem:LANGuage "SCPI"` or
`SYSTem:LANGuage 'SCPI'`

Block data

Block data are a transmission format which is suitable for the transmission of large amounts of data. A command using a block data parameter has the following structure:

Example: `HEADer:HEADer #45168xxxxxxxx`

ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all End or other control signs are ignored until all bytes are transmitted. Data elements comprising more than one byte are transmitted with the byte being the first which was specified by SCPI command "FORMat:BORDer".

3.5.6 Overview of Syntax Elements

The following survey offers an overview of the syntax elements.

: The colon separates the key words of a command.
In a command line the colon after the separating semicolon marks the uppermost command level.

; The semicolon separates two commands of a command line. It does not alter the path.

, The comma separates several parameters of a command.

? The question mark forms a query.

* The asterix marks a common command.

" Quotation marks introduce a string and terminate it.

ASCII character # introduces block data.

␣ A "white space (ASCII-Code 0 to 9, 11 to 32 decimal, e.g.blank) separates header and parameter.

3.6 Description of Commands

3.6.1 Notation

In the following sections, all commands implemented in the instrument are first listed in tables and then described in detail, separated according to the command system. The notation corresponds to the one of the SCPI standards to a large extent. The SCPI conformity information can be taken from the individual description of the commands.

Table of Commands

Command: In the command column, the table provides an overview of the commands and their hierarchical arrangement (see indentations).

Parameter: In the parameter column the requested parameters are indicated together with their specified range.

Unit: The unit column indicates the basic unit of the physical parameters.

Remark: In the remark column an indication is made on:
- whether the command does not have a query form,
- whether the command has only one query form
- whether this command is implemented only with a certain option of the instrument

Indentations

The different levels of the SCPI command hierarchy are represented in the table by means of indentations to the right. The lower the level is, the farther the indentation to the right is. Please observe that the complete notation of the command always includes the higher levels as well.

Example: `SENSe:FREQuency:CENTer` is represented in the table as follows:

`SENSe`	first level
`:FREQuency`	second level
`:CENTer`	third level

In the individual description, the complete notation of the command is given. An example for each command is written out at the end of the individual description.

Upper/lower case notation

Upper/lower case letters serve to mark the long or short form of the key words of a command in the description (see Section 3.5.2). The instrument itself does not distinguish between upper and lower case letters.

Special characters |

A selection of key words with an identical effect exists for several commands. These key words are indicated in the same line, they are separated by a vertical stroke. Only one of these key words has to be indicated in the header of the command. The effect of the command is independent of which of the key words is indicated.

Example: `SENSe:FREQuency:CW|:FIXed`

The two following commands of identical meaning can be formed. They set the frequency of the constantly frequent signal to 1 kHz:

`SENSe:FREQuency:CW 1E3 = SENSe:FREQuency:FIXed 1E3`

A vertical stroke in indicating the parameters marks alternative possibilities in the sense of "or". The effect of the command is different, depending on which parameter is entered.

Example: Selection of the parameters for the command

`INPut:COUPling AC | DC`

If parameter AC is selected, only the AC content is fed through, in the case of DC, the DC as well as the AC content.

[ ] Key words in square brackets can be omitted when composing the header (cf. Section 3.5.2, Optional Keywords). The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards.
Parameters in square brackets can optionally be incorporated in the command or omitted as well.

{ } Parameters in braces can optionally be incorporated in the command either not at all, once or several times.

Description of parameters Due to the standardization, the parameter section of SCPI commands consists always of the same syntactical elements. SCPI has specified a series of definitions therefore, which are used in the tables of commands. In the tables, these established definitions are indicated in angled brackets (<...>) and will be briefly explained in the following (see also Section 3.5.5, "Parameters").

<Boolean> This indication refers to parameters which can adopt two states, "on" and "off". The "off" state may either be indicated by the keyword **OFF** or by the numeric value 0, the "on" state is indicated by **ON** or any numeric value other than zero. Parameter queries are always returned the numeric value 0 or 1.

<numeric_value>
<num>

These indications mark parameters which may be entered as numeric values or be set using specific keywords (character data).

The keywords given below are permitted:

MINimum — This keyword sets the parameter to the smallest possible value.

MAXimum — This keyword sets the parameter to the largest possible value.

DEFault — This keyword is used to reset the parameter to its default value.

UP — This keyword increments the parameter value.

DOWN — This keyword decrements the parameter.

The numeric values associated to MAXimum/MINimum/DEFault can be queried by adding the corresponding keywords to the command. They must be entered following the quotation mark.

Example: `SENSe:FREQuency:CENTer? MAXimum`

returns the maximum possible numeric value of the center frequency as result.

<arbitrary block program data>

This keyword is provided for commands the parameters of which consist of a binary data block.

3.6.2 Common Commands

The common commands are taken from the IEEE 488.2 (IEC 625-2) standard. Same commands have the same effect on different devices. The headers of these commands consist of an asterisk "*" followed by three letters. Many common commands refer to the status reporting system which is described in detail in Section 3.8.

Command	Designation	Parameter	Remark
*CAL?	Calibration Query		query only
*CLS	Clear Status		no query
*ESE	Event Status Enable	0 to 255	
*ESR?	Standard Event Status Query	0 to 255	query only
*IDN?	Identification Query	<string>	query only
*IST?	Individual Status Query	0 to 255	query only
*OPC	Operation Complete		
*OPT?	Option Identification Query		query only
*PCB	Pass Control Back	0 to 30	no query
*PRE	Parallel Poll Register Enable	0 to 255	
*PSC	Power On Status Clear	0 | 1	
*RST	Reset		no query
*SRE	Service Request Enable	0 to 255	
*STB?	Status Byte Query		query only
*TRG	Trigger		no query
*TST?	Self Test Query		query only
*WAI	Wait to continue		no query

***CAL?**

CALIBRATION QUERY triggers a calibration of the instrument and subsequently query the calibration status. Any responses > 0 indicate errors.

***CLS**

CLEAR STATUS sets the status byte (STB), the standard event register (ESR) and the EVENt-part of the QUEStionable and the OPERation register to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

***ESE 0 to 255**
EVENT STATUS ENABLE sets the event status enable register to the value indicated. Query *ESE? returns the contents of the event status enable register in decimal form.

***ESR?**
STANDARD EVENT STATUS QUERY returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.

***IDN?**
IDENTIFICATION QUERY queries the instrument identification.
The device response is for example: "Rohde&Schwarz, FSE, 123456, 1.03"
FSE = Device
123456 = serial number
1.03 = Firmware versions number

***IST?**
INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 | 1). The IST flag is the status bit which is sent during a parallel poll (cf. Section 3.8.3.2).

***OPC**
OPERATION COMPLETE sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request (cf. Section 3.7).

***OPC?**
OPERATION COMPLETE QUERY writes message "1" into the output buffer as soon as all preceding commands have been executed (cf. Section 3.7).

***OPT?**
OPTION IDENTIFICATION QUERY queries the options included in the instrument and returns a list of the options installed. The options are separated from each other by means of commas.

***PCB 0 to 30**
PASS CONTROL BACK indicates the controller address which the IEC-bus control is to be returned to after termination of the triggered action.

***PRE 0 to 255**
PARALLEL POLL REGISTER ENABLE sets parallel poll enable register to the value indicated. Query *PRE? returns the contents of the parallel poll enable register in decimal form.

***PSC 0 | 1**
POWER ON STATUS CLEAR determines whether the contents of the ENABle registers is maintained or reset in switching on.

*PSC = 0 causes the contents of the status registers to be maintained. Thus a service request can be triggered in switching on in the case of a corresponding configuration of status registers ESE and SRE.

*PSC ≠ 0 resets the registers.

Query *PSC? reads out the contents of the power-on-status-clear flag. The response can be 0 or 1.

***RST**
RESET sets the instrument to a defined default status. The command essentially corresponds to pressing the [PRESET] key. The default setting is indicated in the description of the commands.

***SRE 0 to 255**
SERVICE REQUEST ENABLE sets the service request enable register to the value indicated. Bit 6 (MSS mask bit) remains 0. This command determines under which conditions a service request is triggered. Query *SRE? reads the contents of the service request enable register in decimal form. Bit 6 is always 0.

***STB?**
READ STATUS BYTE QUERY reads out the contents of the status byte in decimal form.

***TRG**
TRIGGER triggers all actions waiting for a trigger event (cf. Section "TRIGger subsystem", as well).

***TST?**
SELF TEST QUERY triggers all selftests of the instrument and outputs an error code in decimal form.

***WAI**
WAIT-to-CONTINUE only permits the servicing of the subsequent commands after all preceding commands have been executed and all signals have settled (cf. Section 3.7 and "*OPC" as well).

3.6.3 ABORt Subsystem

The ABORt subsystem contains the commands for aborting triggered actions. An action can be triggered again immediately after being aborted. All commands trigger events which is why they are not assigned any *RST value.

COMMAND	PARAMETER	UNIT	COMMENT
ABORt	–	–	no query

ABORt

This command aborts a current measurement and resets the trigger system.

Syntax: ABORt

Example: "ABOR;INI:IMI"

Features: *RST value: 0
SCPI: conforming

3.6.4 CALCulate Subsystem

The CALCulate subsystem contains commands for converting instrument data, transforming and carrying out corrections. These functions are carried out subsequent to data acquistion, i.e., following the SENSe subsystem.

In the split-screen representation, a distinction is made between CALCulate1 and CALCulate2:

CALCulate1 ≙ screen A;

CALCulate2 ≙ screen B

3.6.4.1 CALCulate:DELTamarker Subsystem

The CALCulate:DELTamarker subsystem checks the delta-marker functions in the instrument.

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2>			
:DELTamarker<1 to 4>			
[:STATe]	<Boolean>	--	
:MODE	ABSolute|RELative		
:AOFF			no query
:TRACe	<numeric_value>	--	
:X	<numeric_value>	HZ|KHZ| MHZ|GHZ| SIMS|USINS	
:Y?	--	--	
:MAXimum			query only
[:PEAK]	--	--	no query
:NEXT	--	--	no query
:RIGHt	--	--	no query
:LEFT	--	--	no query
:MINimum			
[:PEAK]	--	--	no query
:NEXT	--	--	no query
:RIGHt	--	--	no query
:LEFT	--	--	no query
:FUNCtion			
:FIXed			
[:STATe]	<Boolean>		
:RPOint			
:Y	<numeric_value>	DBM	
:OFFSet	<numeric_value>	DB	
:X	<numeric_value>	HZ|KHZ| MHZ|GHZ| SIMS|USINS	
:PNOise			
[:STATe]	<Boolean>		
:RESult?	--	--	query only
:STEP			
[:INCRement]	<numeric_value>	HZ|KHZ| MHZ|GHZ| SIMS|USINS	
:AUTO	<Boolean>	--	

CALCulate[1|2]:DELTamarker[1 to 4][:STATe]

This command switches on or off the selected delta marker. If no indication is made, delta marker 1 is selected automatically.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4][:STATe] ON | OFF

Example: "CALC:DELT3 ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:DELTamarker[1 to 4]:MODE

This command switches over between relative and absolute input of frequency of the delta marker.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MODE ABSolute | RELativ

Example: "CALC:DELT:MODE ABS"

Features: *RST-Wert: REL
SCPI: gerätespezifisch

In the RELative mode, the frequency of the delta marker is programmmed relative to the reference marker. In the ABSolute mode, the frequency is defined by the absolute values.

CALCulate[1|2]:DELTamarker[1 to 4]:AOFF

This command switches off all active delta markers.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:AOFF

Example: "CALC:DELT:AOFF"

Features: *RST value: -
SCPI: device-specific

CALCulate[1|2]:DELTamarker[1 to 4]:TRACe

This command assigns the selected delta marker to the indicated measuring curve.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:TRACe <numeric value>
<numeric value> ::= 1 to 4

Example: "CALC:DELT3:TRAC 2"

Features: *RST value: -
SCPI: device-specific

CALCulate[1|2]:DELTamarker[1 to 4]:X

This command positions the selected delta marker to the indicated frequency (span > 0) or time (span = 0).

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:X <numeric value>
<numeric value> ::= 0 to MAX (frequency) | MAX (sweep time)

Example: "CALC:DELT:X 10.7MHz"

Features: *RST value: -
SCPI: device-specific

CALCulate[1|2]:DELTamarker[1 to 4]:Y?

This command queries the value of the selected marker.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:Y?

Example: "CALC:DELT:Y?"

Features: *RST value: -
SCPI: device-specific

CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum[:PEAK]

This command positions the delta marker to the current maximum value in the trace memory.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum[:PEAK]

Example: "CALC:DELT:MAX"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:NEXT

This command positions the delta marker to the next smaller maximum value in the trace memory.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:NEXT

Example: "CALC:DELT:MAX:NEXT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:RIGHt

This command positions the delta marker to the next smaller maximum value to the right of the current value (i.e., in ascending X direction) in the trace memory.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:RIGHt

Example: "CALC:DELT:MAX:RIGH"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:LEFT

This command positions the delta marker to the next smaller maximum value to the left of the current value (i.e., in descending X direction) in the trace memory.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:LEFT

Example: "CALC:DELT:MAX:LEFT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:MINimum[:PEAK]

This command positions the delta marker to the current minimum value in the trace memory.

Syntax: [1|2]:DELTamarker[1 to 4]:MINimum[:PEAK]

Example: "CALC:DELT:MIN"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:NEXT

This command positions the delta marker to the next higher minimum value in the trace memory.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:NEXT

Example: "CALC:DELT:MIN:NEXT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:RIGHt

This command positions the delta marker to the next higher minimum value to the right of the current value (ie in ascending X direction).

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:RIGHt

Example: "CALC:DELT:MIN:RIGH"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:LEFT

This command positions the delta marker to the next higher minimum value to the left of the current value (ie in descending X direction).

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:LEFT

Example: "CALC:DELT:MIN:LEFT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed[:STATe]

This command switches the relative measurement to a fixed reference value on or off.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed[:STATe] ON | OFF

Example: "CALC:DELT:FUNC:FIX ON"

Features: *RST value: OFF
SCPI: device-specific.

The reference value is independent of the current trace.

CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:Y

This command defines a new fixed reference value for the relative measurement.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:Y
<numeric_value>

Example: "CALC:DELT:FUNC:FIX:RPO:X -10dBm"

Features: *RST value: - (FUNction:FIXed[:STATe] is set to OFF)
SCPI: device-specific

The reference value is independent of the current trace.

CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:Y:OFFSet

This command defines an additional level offset for the relative measurement.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:Y:OFFSet <numeric_value>

Example: "CALC:DELT:FUNC:FIX:RPO:Y:OFFS 10dB"

Features: *RST value: 0 dB
SCPI: device-specific

The level offset is included in the output of the level value.

CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:X

This command defines the new fixed reference frequency or time for the relative measurement.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:X <numeric_value>

Example: "CALC:DELT:FUNC:FIX:RPO:X 10.7MHz"

Features: *RST value: - (FUNCtion:FIXed[:STATe] is set to OFF)
SCPI: device-specific

The reference value is independent of the current trace. With span = 0, the reference time, otherwise the reference frequency is defined.

CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:PNOise[:STATe]

This command switches the measurement of the phase noise on or off.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:PNOise[:STATe] ON | OFF

Example: "CALC:DELT:FUNC:PNO ON"

Features: *RST value: OFF
SCPI: device-specific

When the phase noise is measured, the correction values for the bandwidth and the log amplifier are automatically considered. The measurement uses the reference values defined by FUNCtion:FIXed:RPOint:X or Y.

CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:PNOise:RESult?

This command queries the result of the phase noise measurement.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:PNOise:RESult?

Example: "CALC:DELT:FUNC:PNO:RES?"

Features: *RST value: -
SCPI: device-specific

This command is only a query which is why it is not assigned an *RST value.

CALCulate[1|2]:DELTamarker[1 to 4]:STEP[:INCRement]

This command defines the delta marker stepwidth.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:STEP[:INCRement] <numeric_value>

Example: "CALC:DELT:STEP 10kHz" (frequency domain)
"CALC:DELT:STEP 5ms" (time domain)

Features: *RST value: - (STEP is set to AUTO)
SCPI: device-specific

CALCulate[1|2]:DELTamarker[1 to 4]:STEP:AUTO

This command switches the automatic adaption of the marker stepwidth on or off.

Syntax: CALCulate[1|2]:DELTamarker[1 to 4]:STEP:AUTO ON | OFF

Example: "CALC:DELT:STEP:AUTO OFF"

Features: *RST value: ON
SCPI: device-specific

With AUTO ON, the stepwidth is 10% of the span.

3.6.4.2 CALCulate:DLINe Subsystem

The CALCulate:DLINe subsystem checks the display lines in the instrument, i.e., the level, frequency and time lines (depending on the X-axis) as well as threshold and reference lines.

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2>			
:DLINe<1|2>	<numeric_value>	DBM	
:STATe	<Boolean>		
:THReshold	<numeric_value>	DBM	
:STATe	<Boolean>		
:RLINe	<numeric_value>	DBM	
:STATe	<Boolean>		
:FLINe<1|2>	<numeric_value>	HZ	
:STATe	<Boolean>		
:TLINe<1|2>	<numeric_value>	S	
:STATe	<Boolean>		

CALCulate[1|2]:DLINe[1|2]

This command defines the position of the display line.

Syntax: CALCulate:DLINe[1|2] <numeric_value>
<numeric_value>::= MINimum to MAXimum (depending on current unit)

Example: "CALC:DLIN -20dBm"

Features: *RST value: - (STATe to OFF)
SCPI: device-specific

The display lines mark the given level in the display.

CALCulate[1|2]:DLINe[1|2]:STATe

This command switches the display line on or off.

Syntax: CALCulate:DLINe[1|2]:STATe ON | OFF

Example: "CALC:DLIN2:STAT OFF"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:THReshold

This command defines the position of the thresholds.

Syntax: CALCulate:THReshold <numeric_value>
<numeric_value>::= MINimum to MAXimum (depending on current unit)

Example: "CALC:THR -82dBm"

Features: *RST value: - (STATe to OFF)
SCPI: device-specific

For marker scan functions MAX PEAK, NEXT PEAK etc., the threshold serves as the lowest limit for maximum or minimum search.

CALCulate[1|2]:THReshold:STATe

This command switches the threshold on or off.

Syntax: CALCulate:THReshold ON | OFF

Example: "CALC:THR:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:RLINe

This command defines the position of the reference line.

Syntax: CALCulate:RLINe <numeric_value>
<numeric_value>::= MINimum to MAXimum (depending on the current unit)

Example: "CALC:RLIN -10dBm"

Features: *RST value: - (STATe to OFF)
SCPI: device-specific

The reference line serves as a reference for the arithmetic operation of traces.

CALCulate[1|2]:RLINe:STATe

This command switches the reference line on or off.

Syntax: CALCulate:RLINe:STATe ON | OFF

Example: "CALC:RLIN:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:FLINe[1|2]

This command defines the position of the frequency lines.

Syntax: CALCulate:FLINe[1|2] <numeric_value>
<numeric_value>::= 0 GHz to f_{max}

Example: "CALC:FLIN2 120MHz"

Features: *RST value: - (STATe to OFF)
SCPI: device-specific

The frequency lines mark the given frequencies in the display. Frequency lines are only valid for a SPAN >0.

CALCulate[1|2]:FLINe[1|2]:STATe

This command switches the frequency line on or off.

Syntax: CALCulate:FLINe[1|2]:STATe ON | OFF

Example: "CALC:FLIN2:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:TLINe[1|2]

This command defines the position of the time lines.

Syntax: CALCulate:TLINe[1|2] <numeric_value>
<numeric_value>::= 0 to 1000s

Example: "CALC:TLIN 10ms"

Features: *RST value: - (STATe to OFF)
SCPI: device-specific

The time lines mark the given times in the display. Time lines are only valid for a SPAN = 0.

CALCulate[1|2]:TLINe[1|2]:STATe

This command switches the time line on or off.

Syntax: CALCulate:TLINe[1|2]:STATe ON | OFF

Example: "CALC:TLIN2:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

3.6.4.3 CALCulate:FEED - Subsystem

The CALCulate:FEED subsystem selects the measured data.

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2> :FEED	<string>		Option FSE-B7 no query

CALCulate[1|2]:FEED

This command selects the measured data that are to be displayed

Syntax: CALCulate[1|2]:FEED <string>
<string>::= 'XTIM:DDEM:MEAS' |
'XTIM:DDEM:REF' |
'XTIM:DDEM:ERR:MPH' |
'XTIM:DDEM:ERR:VECT' |
'XTIM:DDEM:SYMB' |
'TCAP'

Example: "CALC:FEED 'XTIM:DDEM:SYMB'"

Features: *RST value: 'XTIM:DDEM:MEAS'
SCPI: conforming

The string parameters have the following meaning:

'XTIM:DDEM:MEAS'	Test signal (filtered, synchronized to symbol clock)
'XTIM:DDEM:REF'	Reference signal (internally generated from demodulated test signal)
'XTIM:DDEM:ERR:MPH'	Error signal (magnitude and phase error)
'XTIM:DDEM:ERR:VECT'	Vector error signal
'XTIM:DDEM:SYMB'	Symbol table (demodulated bits and table with modulation errors)
'TCAP'	Test signal in capture buffer

3.6.4.4 CALCulate:FORMat Subsystem

The CALCulate:FORMat subsystem determines further processing and conversion of measured data.

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2> :FORMat	MAGNitude | PHASe | UPHase | RIMag | FREQuency | IEYE | QEYE | TEYE | COMP | CONS		Option FSE-B7

CALCulate[1|2]:FORMat

This command defines the display of the traces.

Syntax: CALCulate[1|2]:FORMat MAGNitude | PHASe | UPHase | RIMag | FREQuency | IEYE | QEYE | TEYE | COMP | CONS

Example: "CALC:FORM CONS"

Features: *RST value: MAGNitude
SCPI: conforming

The parameters have the following meaning:

MAGNitude	Display of the magnitude in the time domain
PHASe | UPHase	Display of the phase in the time domain with or without ("unwrapped") limitation to ±180°
RIMag	Display of the time characteristic of inphase and quadrature component
FREQuency	Display of the frequency response in the time domain
IEYE | QEYE	Eye diagram of the inphase or quadrature component
TEYE	Display of the trellis diagram
COMP	Display of the polar vector diagram (complex)
CONS	Display of the polar vector diagaram (constellation)

3.6.4.5 CALCulate:LIMit Subsystem

The CALCulate:LIMit subsystem comprises the limit lines and the corresponding limit checks. Limit lines can be defined as upper and lower limit lines. The individual values of the limit lines correspond to the values of the X-axis (CONTrol) which have to have the same number.

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2>			
:LIMit			
:STATe	<Boolean>	--	
:UNIT	DBM | DBPW | WATT | DBUV | VOLT | DBUA | AMPere		
:CONTrol			
[:DATA]	<numeric_value>,<numeric_value>..	HZIs	
:DOMain	FREQuency | TIME		
:UPPer			
[:DATA]	<numeric_value>,<numeric_value>..	DBM	
:STATe	<Boolean>	--	
:LOWer			
[:DATA]	<numeric_value>,<numeric_value>..	DBM	query only
:STATe	<Boolean>	--	
:FAIL?			no query
:CLEar			
[:IMMediate]	--	--	

CALCulate[1\|2]:LIMit:STATe

This command switches the limit check on or off.

Syntax: CALCulate[1|2]:LIMit:STATe ON | OFF

Example: "CALC:LIM:STAT ON"

Features: *RST value: OFF
SCPI: conforming

The result of the limit check can be queried with CALCulate:LIMit:FAIL?.

CALCulate[1\|2]:LIMit:CONTrol[:DATA]

This command defines the value of the X-axis (frequencies or times) for the limit lines UPPER or LOWER.

Syntax: CALCulate[1|2]:LIMit:CONTrol[:DATA] <numeric_value>,<numeric_value>..

Example: "CALC:LIM:CONT 1MHz,30MHz,300MHz,1GHz"

Features: *RST value: - (LIMit:STATe is set to OFF)
SCPI: conforming

The number of values for the CONTrol axis and the corresponding UPPer- and/or LOWer limit lines have to be identical.

CALCulate[1|2]:LIMit:CONTrol:DOMain

This command defines the X-axis in the frequency or time domain.

Syntax: CALCulate[1|2]:LIMit:CONTrol:DOMain FREQuency | TIME

Example: "CALC:LIM:CONT:DOM TIME"

Features: *RST value: FREQuency
SCPI: device-specific

CALCulate[1|2]:LIMit:UPPer[:DATA]

This command defines the values for the upper limit lines.

Syntax: CALCulate[1|2]:LIMit:UPPer[:DATA] <numeric_value>,<numeric_value>..

Example: "CALC:LIM:UPP -10,0,0,-10"

Features: *RST value: - (LIMit:STATe is set to OFF)
SCPI: conforming

The number of values for the CONTrol axis and the corresponding UPPer limit line have to be identical. If the measured values exceed the UPPer limit line, the limit check signals errors.

CALCulate[1|2]:LIMit:UPPer:STATe

This command switches the limit check with the limit line on or off.

Syntax: CALCulate[1|2]:LIMit:UPPer:STATe ON | OFF

Example: "CALC:LIM:UPPer:STAT ON"

Features: *RST value: OFF
SCPI: conforming

The result of the limit check can be queried with CALCulate:LIMit:FAIL?.

CALCulate[1|2]:LIMit:LOWer[:DATA]

This command defines the values for the lower limit lines.

Syntax: CALCulate[1|2]:LIMit:LOWer[:DATA] <numeric_value>,<numeric_value>..

Example: "CALC:LIM:LOW -30,-40,-40,-30"

Features: *RST value: - (LIMit:STATe is set to OFF)
SCPI: conforming

The number of values for the CONTrol axis and the corresponding LOWer limit line have to be identical. If the measured values violate the LOWer limit line, the limit check signals errors.

CALCulate[1|2]:LIMit:LOWer:STATe

This command switches the limit check with the limit line on or off.

Syntax: CALCulate[1|2]:LIMit:LOWer:STATe ON | OFF

Example: "CALC:LIM:LOWer:STAT ON"

Features: *RST value: OFF
SCPI: conforming

The result of the limit check can be queried with CALCulate:LIMit:FAIL?.

CALCulate[1|2]:LIMit:FAIL?

This command queries the result of the limit check.

Syntax: CALCulate[1|2]:LIMit:FAIL?

Example: "CALC:LIM:FAIL?"

Features: *RST value: -
SCPI: conforming

The result of the limit check responds with 0 in case of PASS and with 1 in case of FAIL.

CALCulate[1|2]:LIMit:CLEar[:IMMediate]

This command deletes the result of the current limit check.

Syntax: CALCulate[1|2]:LIMit:CLEar[:IMMediate]

Example: "CALC:LIM:CLE"

Features: *RST value: -
SCPI: conforming

This command is an event which is why it is not assigned an *RST value.

3.6.4.6 CALCulate:MARKer Subsystem

The CALCulate:MARKer subsystem checks the marker functions in the instrument.

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2>			
:MARKer<1 to 4>			
[:STATe]	<Boolean>	–	
:AOFF			no query
:TRACe	<numeric_value>	–	
:X	<numeric_value>	HZ|KHZ |MHZ|GHZ |S|MS|US|NS	
:COUNt	<Boolean>	–	
:RESolution	<numeric_value>	HZ	
:FREQuency?	–	–	query only
:Y?	–	–	query only
:MAXimum			
[:PEAK]	–	–	no query
:NEXT	–	–	no query
:RIGHt	–	–	no query
:LEFT	–	–	no query
:MINimum			
[:PEAK]	–	–	no query
:NEXT	–	–	no query
:RIGHt	–	–	no query
:LEFT	–	–	no query
:FUNCtion			
:NDBDown	<numeric_value>	DB	
:STATe	<Boolean>		
:RESult?	–	–	query only
:ZOOM	<numeric_value>	HZ	no query
:NOISe			
[:STATe]	<Boolean>		
:RESult?	–	–	query only
:DEModulation			
:SELect	AM|FM		
[:STATe]	<Boolean>		
:HOLDoff	<numeric_value>	S	
:SFACtor	<expr>		
:STATe	<Boolean>		
:RESult?	–	–	query only
:STRack			
[:STATe]	<Boolean>		option FSE-B7
:DDEMod			query only
:RESult?	MERM | MEPK | MEPS | PERM | PEPK | PEPS |EVRM | EVPK | EVPS | IQOF | IQIM | ADR | FERR		option FSE-B7
:READout	MPHase | RIMaginary		
:STEP			
[:INCRement]	<numeric_value>	HZ|KHZ| MHZ|GHZ| S|MS|US|NS	
:AUTO	<Boolean>	–	

CALCulate[1|2]:MARKer[1 to 4][:STATe]

This command switches on or off the currently selected marker. If no indication is made, marker 1 is selected automatically.

Syntax: CALCulate[1|2]:MARKer[1 to 4][:STATe] ON | OFF

Example: "CALC:MARK3 ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:AOFF

This command switches off all active markers.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:AOFF

Example: "CALC:MARK:AOFF"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:TRACe

This command assigns the selected marker (1 to 4) to the indicated test curve.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:TRACe <numeric value>
<numeric value> ::= 1 to 4

Example: "CALC:MARK3:TRAC 2"

Features: *RST-value -
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:X

This command positions the selected marker to the indicated frequency (span > 0) or time (span = 0).

Syntax: CALCulate[1|2]:MARKer[1 to 4]:X <numeric value>
<numeric value> ::= 0 to MAX (frequency) | MAX (sweep time)

Example: "CALC:MARK:X 10.7MHz"

Features: *RST value: -
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:COUNt

This command switches on or off the frequency counter at the marker position.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:COUNt ON|OFF

Example: "CALC:MARK:COUN ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:COUNt:RESolution

This command specifies the resolution of the frequency counter.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:COUNt:RESolution <numeric value>
<numeric value> ::= 0.1 | 1 | 10 | 100 | 1000 | 10000 Hz

Example: "CALC:MARK:COUN:RES 1kHz"

Features: *RST value: 1kHz
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:COUNt:FREQuency

This command queries the result of the frequency counter.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:COUNt:FREQuency?

Example: "CALC:MARK:COUN:FREQ?"

Features: *RST value: -
SCPI: device-specific

This command is only a query and thus has no *RST value.

CALCulate[1|2]:MARKer[1 to 4]:Y?

This command queries the selected marker value.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:Y?

Example: "CALC:MARK:Y?"

Features: *RST value: -
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:MAXimum[:PEAK]

This command positions the marker to the current maximum value in the trace memory.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MAXimum[:PEAK]

Example: "CALC:MARK:MAX"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:MAXimum:NEXT

This command positions the marker to the next lower maximum value in the trace memory.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MAXimum:NEXT

Example: "CALC:MARK:MAX:NEXT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:MAXimum:RIGHt

This command positions the marker to the next smaller maximum value to the right of the current value (i.e., in ascending X direction) in the trace memory.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MAXimum:RIGHt

Example: "CALC:MARK:MAX:RIGH"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:MAXimum:LEFT

This command positions the marker to the next smaller maximum value to the left of the current value (i.e., in descending X direction) in the trace memory.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MAXimum:LEFT

Example: "CALC:MARK:MAX:LEFT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:MINimum[:PEAK]

This command positions the marker to the current minimum value in the trace memory.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MINimum[:PEAK]

Example: "CALC:MARK:MIN"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:MINimum:NEXT

This command positions the marker to the next higher minimum value in the trace memory.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MINimum:NEXT

Example: "CALC:MARK:MIN:NEXT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:MINimum:RIGHt

This command positions the marker to the next higher minimum value to the right of the current value (ie in ascending X direction).

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MINimum:RIGHt

Example: "CALC:MARK:MIN:RIGH"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:MINimum:LEFT

This command positions the marker to the next higher minimum value to the left of the current value (ie in descending X direction).

Syntax: CALCulate[1|2]:MARKer[1 to 4]:MINimum:LEFT

Example: "CALC:MARK:MIN:LEFT"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown

This command defines the "N dB Down" value.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown <numeric_value>

Example: "CALC:MARK:FUNC:NDBD 3dB"

Features: *RST value: 6dB
SCPI: device-specific

The temporary markers T1 and T2 are positioned by n dB below the active reference marker. The frequency spacing of these markers can be queried with CALCulate:MARKer:FUNCtion:NDBDown:RESult?.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown:STATe

This command switches the "N dB Down" function on or off.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown:STATe ON | OFF

Example: "CALC:MARK:FUNC:NDBD:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown:RESult?

This command queries the frequency spacing (bandwidth) of the "N dB Down" markers.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown:RESult?

Example: "CALC:MARK:FUNC:NDBD:RES?"

Features: *RST value: -
SCPI: device-specific

This command is only a query which is why it is not assigned an *RST value.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:ZOOM

This command defines the range to be enlarged around the active marker.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:ZOOM <numeric_value>

Example: "CALC:MARK:FUNC:ZOOM 1kHz"

Features: *RST value: -
SCPI: device-specific

The subsequent frequency sweep is stopped at the marker position and the frequency of the signal is counted. This frequency becomes the new center frequency, the zoomed span is then set. This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NOISe[:STATe]

This command switches the noise measurement on or off.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NOISe[:STATe]ON | OFF

Example: "CALC:MARK:FUNC:NOIS ON"

Features: *RST value: OFF
SCPI: device-specific

The noise power density is measured at the position of the markers. The result can be queried with CALCulate:MARKer:FUNCtion:NOISe:RESult?.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NOISe:RESult?

This command queries the result of the noise measurement.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NOISe:RESult?

Example: "CALC:MARK:FUNC:NOIS:RES?"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation:SELect

This command selects the demodulation type.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation:SELect AM | FM

Example: "CALC:MARK:FUNC:DEM:SEL FM"

Features: *RST value: AM
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation[:STATe]

This command switches the demodulation on or off.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation[:STATe] ON | OFF

Example: "CALC:MARK:FUNC:DEM ON"

Features: *RST value: OFF
SCPI: device-specific

With demodulation switched on, the frequency sweep is stopped at the marker position and the signal is demodulated during the given stop time.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation:HOLDoff

This command defines the duration of the stop time for the demodulation.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation:HOLDoff
<num_value>
<numeric_value>::= 10ms to 1000s

Example: "CALC:MARK:FUNC:DEM:HOLD 3s"

Features: *RST value: - (DEModulation is set to OFF)
SCPI: device-specific

With demodulation switched on, the frequency sweep is stopped at the marker position and the signal is demodulated during the given stop time.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor

This command defines the shape factor measurement 60dB/6dB or 60dB/3dB.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor
<expr>::=(60dB/3dB) | (60dB/6dB)

Example: "CALC:MARK:FUNC:SFAC (60dB/3dB)"

Features: *RST value: (60dB/6dB)
SCPI: device-specific

The temporary markers T1 to T4 are positioned in pairs by 60dB and by 3dB or 6dB below the active reference marker. The frequency spacing ratio of these markers - the shape factor - can be queried with CALCulate:MARKer:FUNCtion:SFACtor:RESult?.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor:STATe

This command switches the shape factor measurement on or off.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor:STATe ON | OFF

Example: "CALC:MARK:FUNC:SFAC:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor:RESult?

This command queries the result of the shape factor measurement.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor:RESult?

Example: "CALC:MARK:FUNC:SFAC:RES?"

Features: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned an *RST value and has no query.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:STRack[:STATe]

This command switches the signal-track function on or off.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:STRack[:STATe] ON | OFF

Example: "CALC:MARK:FUNC:STR ON"

Features: *RST value: OFF
SCPI: device-specific

With SIGNAL TRACK function activated, the maximum signal is determined after each frequency sweep and the center frequency of this signal is set. With drifting signals the center frequency follows the signal.

CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DDEMod:RESult?

This command queries the error measurement results of digital demodulation.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DDEMod:RESult?
MERM | PERM | EVRM | IQOF | ADR | FERR

Example: "CALC:MARK:FUNC:DDEM:RES? EVRM"

Features: *RST value: -
SCPI: device-specific

This command is only valid in conjunction with Option FSE-B7.

MERM	magnitude error in %rms
MEPK	maximum of magnitude error in %pk
MEPS	symbol number by which the maximum of the magnitude error occured
PERM	phase error in deg
PEPK	maximum of phase error in deg
PEPS	symbol number by which the maximum of the phase error occured
EVRM	vector error in %rms
EVPK	maximum of vector error in %pk
EVPS	symbol number by which the maximum of the vector error occurred
IQOF	I/Q-offset error in %
IQIM	I/Q Imbalance in %
FERR	frequency error in Hz
ADR	amplitude drop in dB/symbol

CALCulate[1|2]:MARKer[1 to 4]:READout

This command determines the type of the marker display.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:READout MPHase | RIMaginary

Example: "CALC:MARK:READ RIM"

Features: *RST value: -
SCPI: device-specific

This command is only valid in conjunction with Option FSE-B7.

CALCulate[1|2]:MARKer[1 to 4]:STEP[:INCRement]

This command defines the marker stepwidth.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:STEP[:INCRement] <numeric_value>

Example: "CALC:MARK:STEP 10kHz" (frequency domain)
"CALC:MARK:STEP 5ms" (time domain)

Features: *RST value: - (STEP is set to AUTO)
SCPI: device-specific

CALCulate[1|2]:MARKer[1 to 4]:STEP:AUTO

This command switches the automatic adaption of the marker stepwidth on or off.

Syntax: CALCulate[1|2]:MARKer[1 to 4]:STEP:AUTO ON | OFF

Example: "CALC:MARK:STEP:AUTO OFF"

Features: *RST value: ON
SCPI: device-specific

With AUTO ON, the stepwidth is 10% of the span.

3.6.5 CALibration Subsystem

The commands of the CALibration subsystem perform instrument calibrations.

COMMAND	PARAMETER	UNIT	COMMENT
CALibration			
[:ALL]?	–	–	query only
:BANDwidth			
[:RESolution]?	–	–	query only
:BWIDth			
[:RESolution]?	–	–	query only
:IQ?	–	–	query only / FSE-B7 only
:LDETector?	–	–	query only
:LOSuppression?	–	–	query only
:PPEak?	–	–	query only / FSEM only
:SHORt?	–	–	query only
:STATe	<Boolean>	–	

CALibration[:ALL]?

This command performs a complete calibration of the analyzer. A "0" is returned if the calibration was successful.

Syntax: CALibration[:ALL]?

Example: "CAL?"

Features: *RST value: -
SCPI: conforming

CALibration:BANDwidth | BWIDth[:RESolution]?

This command performs a calibration of the filter bandwidths. A "0" is returned if the calibration was successful.

Syntax: CALibration:BANDwidth|BWIDth[:RESolution]?

Example: "CAL:BAND?"

Features: *RST value: -
SCPI: device-specific

CALibration:IQ?

This command performs a calibration of the option vector analyzer. A "0" is returned if the calibration was successful..

Syntax: CALibration:IQ?

Example: "CAL:IQ?"

features: *RST value: -
SCPI: device specific

This command is only valid in conjunction with Option FSE-B7.

CALibration:LDETector?

This command performs a calibration of the log module's characteristic and of the detectors. A "0" is returned if the calibration was successful.

Syntax: CALibration:LDETector?

Example: "CAL:LDET?"

Features: *RST value: -
SCPI: device-specific

CALibration:LOSuppression?

This command performs a calibration of the local oscillator supression. . A "0" is returned if the calibration was successful.

Syntax: CALibration:LOSuppression?

Example: "CAL:LOS?"

Features: *RST value: -
SCPI: device-specific

This command is only valid by model '30 instruments or by instruments which have been retrofitted.

CALibration:PPEak?

This command performs a calibration of the tracking YIG filter (preselector peaking). A "0" is returned if the calibration was successful.

Syntax: CALibration:PPEak?

Beispiel: "CAL:PPE?"

Eigenschaften: *RST-Wert: -
SCPI: gerätespezifisch

This command is only valid by the models FSEM20 and FSEM30.

CALibration:SHORt?

This command performs a short calibration. A "0" is returned if the calibration was successful.

Syntax: CALibration:SHORt?

Example: "CAL:SHOR?"

Features: *RST value: -
SCPI: device-specific

CALibration:STATe

This command determines whether (ON) or not (OFF) the current calibration data are taken into consideration.

Syntax: CALibration:STATe ON | OFF

Example: "CAL:STAT OFF"

Features: *RST value: -
SCPI: conforming

3.6.6 DIAGnostic Subsystem

The DIAGnostic subsystem contains the commands which support instrument diagnostics for maintenance, service and repair. In accordance with the SCPI standard, all of these commands are device-specific.

COMMAND	PARAMETER	UNIT	COMMENT
DIAGnostic :SERVice :INPut [:SELect] :FUNCtion :NSOurce	CALibration | RF <numeric_value>,>numeric_value>.. <Boolean>	–	

DIAGnostic:SERVice:INPut[:SELect]

This command toggles between the RF input on the front panel and the internal 120-MHz reference signal.

Syntax: DIAGnostic:SERVice:INPut[:SELect] CALibration|RF

Example: `"DIAG:SERV:INP CAL"`

Features: *RST value: RF
SCPI: device-specific

DIAGnostic:SERVice:FUNCtion

This command activates a service function.

Syntax: DIAGnostic:SERVice:FUNCtion <numeric_value>,<numeric_value>...

Example: `"DIAG:SERV:FUNC 2,0,2,12,1"`

Features: *RST value: -
SCPI: device-specific

The service function is selected via five parameters: functional group number, board number, function number, parameter 1 and parameter 2.

See service manual 1065.6016.24.

DIAGnostic:SERVice:NSOurce

This command switches the 28-V supply at the rear connector of the noise source on and off.

Syntax: DIAGnostic:SERVice:NSOurce ON | OFF

Example: `"DIAG:SERV:NSO ON"`

Features: *RST value: OFF
SCPI: device-specific

3.6.7 DISPlay Subsystem

The DISPLay subsystem controls the selection and presentation of textual and graphic information as well as of trace data on the display.
The displays in the split-screen mode are assigned to WINDow 1 or 2.

COMMAND	PARAMETER	UNIT	COMMENT
DISPlay			
:FORMat	SINGle|SPLit		
:PROgram			
[:MODE]	<Boolean>		Option FSE-B15
[:WINDow<1|2>]			
:TRACe<1 to 4>			
:Y			
[:SCALe]	<numeric_value>	DB	
:RLEVel	<numeric_value>	DBM	
:OFFSet	<numeric_value>	DB	
:SPACing	LINear|LOGarithmic|PERCent	--	
:MODE	WRITe|VIEW|AVERage|MAXHold|MINHold	--	
[:STATe]	<Boolean>	--	
:SYMBol	DOTS | BARS | OFF		Option FSE-B7
:EYE			
COUNt	<numeric_value>	SYM	Option FSE-B7

DISPlay:FORMat

This command switches the test result display between FULL SCREEN and SPLIT SCREEN.

Syntax: DISPlay:FORmat SINGle \| SPLit

Example: "DISP:FORM SPL"

Features: *RST value: SINGle
SCPI: device-specific

DISPlay:PROGram[:MODE]

This command switches the display between the measuring instrument and the computer function.

Syntax: DISPlay:PROGram[:MODE] ON \| OFF

Example: "DISP:PROG ON"

Features: *RST value: OFF
SCPI: device-specific

This command is only valid in conjunction with Option FSE-B15 (Computer Function).

DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:Y[:SCALe]

This command defines the display range of the Y-axis (level axis) with logarithmic scaling (DISP:TRAC:Y:SPAC LOG).

For linear scaling, (DISP:TRAC:Y:SPAC LIN | PERC) the display range is fixed.

Syntax: DISPlay[:WINDow[1|2]:TRACe[1 to 4]:Y[:SCALe] <numeric_value>
<numeric_value>::= 10dB to 200dB

Example: "DISP:TRAC:Y 110dB"

Features: *RST value: 100dB
SCPI: device-specific

The display range cannot be set with linear scaling (DISP:TRAC:Y:SPAC LIN | PERC).

DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:Y[:SCALe]:RLEVel

This command defines the reference level.

Syntax: DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:Y[:SCALe]:RLEVel <numeric_value>
<numeric_value>::= -200dBm to 200dBm

Example: "DISP:TRAC:Y:RLEV -60dBm"

Features: *RST value: -20dBm
SCPI: conforming

DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:Y[:SCALe]:RLEVel:OFFSet

This command defines the offset of the reference level.

Syntax: DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:Y[:SCALe]:RLEVel:OFFSet
<numeric_value>
<numeric_value>::= -200dB to 200dB

Example: "DISP:TRAC:Y:RLEV:OFFS -10dB"

Features: *RST value: 0dB
SCPI: konform

DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:Y:SPACing

This command toggles between linear and logarithmic display.

Syntax: DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:Y:SPACing
LINear | LOGarithmic | PERCent

Example: "DISP:TRAC:Y:SPAC LIN"

Features: *RST value: LOGarithmic
SCPI: conforming

The linear display can be LIN/% (PERCent) or LIN/dB (LINear).

DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:MODE

This command defines the type of display and the evaluation of the traces.

Syntax: DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:MODE
WRITe | VIEW | AVERage | MAXHold | MINHold

Example: "DISP:TRAC3:MODE MAXH"

Features: *RST value: WRITe for TRACe1, STATe OFF for TRACe2 to 4
SCPI: device-specific

DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:SYMBol

This command determines the display of the points of decision on the trace.

Syntax: DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:SYMBol DOTS | BARS | OFF

Example: "DISP:TRAC:SYMB BARS"

Features: *RST value: OFF
SCPI: device-specific

This command is only valid in conjunction with Option FSE-B7.

DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:EYE:COUNt

This command determines the display range of the eye diagram in symbols.

Syntax: DISPlay[:WINDow[1|2]]:TRACe[1 to 4]:EYE:COUNt <numeric_value>
<numeric_value> ::= 1 to Result Length

Example: "DISP:TRAC:EYE:COUNt 5"

Features: *RST value: 2
SCPI: device-specific

This command is only valid in conjunction with Option FSE-B7.

DISPlay[:WINDow[1|2]]:TRACe[1 to 4][:STATe]

This command switches the display of the corresponding trace on or off.

Syntax: DISPlay[:WINDow[1|2]]:TRACe[1 to 4][:STATe] ON | OFF

Example: "DISP:TRAC3 ON"

Features: *RST value: ON for TRACe1, OFF for TRACe2 to 4
SCPI: conforming

3.6.8 FORMat Subsystem

The FORMat subsystem specifies the data format of the data transmitted from and to the analyzer.

COMMAND	PARAMETER	UNIT	COMMENT
FORMat [:DATA]	ASCii|REAL|UINT[,<numeric_value>]	-	

FORMat[:DATA]

This command specifies the data format of the data transmitted from and to the analyzer.

Syntax: FORMat[:DATA] ASCii | REAL| UINT[,<numeric_value>]
<numeric_value> ::= 32

Example:
```
"FORM REAL,32"
"FORM ASC"
```

Features: *RST value: ASCii
SCPI: conforming

The data format is either ASCii or one of the formats REAL or UINT (Unsigned Integer). ASCii data are transmitted in plain text, separated by commas. REAL data are transmitted as 32-bit IEEE 754 floating-point numbers in the "definite length block". The format UINT is only used in conjunction with the option FSE-B7 for the symbol table.

The FORMat command is valid for the transmission of trace data. The data format of trace data received by the analyzer is automatically recognized, irregardless of the format which is programmed.

3.6.9 HCOPy Subsystem

The HCOPy subsystem controls the output of display information for documentation purposes on output devices or files.

COMMAND	PARAMETER	UNIT	COMMENT
HCOPy			
:ABORt	--	--	no query
:DESTination[1|2]	'SYST:COMM:GPIB'| 'SYST:COMM:SER1'| 'SYST:COMM:SER2'| 'SYST:COMM:CENT'| 'MMEM'		no query
:DEVice			
:COLor	<Boolean>		
:LANGuage[1|2]	HPGL|PCL4|PCL5|POSTscript|ESCP| WMF|PCX		
:PRESet[1|2]	<Boolean>		
:RESolution[1|2]	<numeric_value>		
[:IMMediate[1|2]]	--	--	no query
:ITEM			
:ALL			no query
:FFEed[1|2]			
:STATe	<Boolean>		
:LABEL			
:TEXT	<string>		
:PFEed[1|2]			
:STATe	<Boolean>		
:WINDow[1|2]			
:TABle			
:STATe	<Boolean>		
:TEXT	<string>		
:TRACe			
:STATe	<Boolean>		
:CAINcrement	<Boolean>		
:PAGE			
:DIMensions			
:QUADrant<1 to 4>			no query
:FULL			no query
:ORIentation[1|2]	LANDscape|PORTrait		

HCOPy:ABORt

This command aborts a running hardcopy output.

Syntax: HCOPy:ABORt

Example: "HCOP:ABOR"

Features: *RST value: -
SCPI: conforming

This command is an event which is why it is not assigned an *RST value and no query.

HCOPy:DESTination[1|2]

This command selects the interface and the configuration (1 or 2) for the hardcopy device.

Syntax: HCOPy:DESTination[1|2] "SYST:COMM:GPIB' | 'SYST:COMM:SER1' | 'SYST:COMM:SER2' | 'SYST:COMM:CENT' | 'MMEM'

Example: "HCOP:DEST2 'SYST:COMM:SER2'"

Features: *RST value: -
SCPI: conforming

This command is an event which is why it is not assigned an *RST value and no query. HCOPy:DESTination 'MMEM' creates a file for the hardcopy output. Command MMEM:NAME <file_name> defines the file name.

HCOPy:DEVice:COLor

This command selects between colour and monochrome hardcopy of the screen.

Syntax: HCOPy:DEVice:COLor ON|OFF

Example: "HCOP:DEV:COL ON"

Features: *RST value: OFF
SCPI: conforming

HCOPy:DEVice:LANGuage[1|2]

This command determines the data format of the printout.

Syntax: HCOPy:DEVice:LANGuage HPGL| PCL4| PCL5| POSTscript| ESCP| WMF| PCX

Example: "HCOP:DEV:LANG WMF"

Features: *RST value: -
SCPI: conforming

HPGL data format for outputting to a plotter,
PCL4 and PCL5 data formats for laser and ink jet printers.
POSTscript a page description language,
ESCP data format for a 24-pin printer.
WMF (WINDOWS Metafile Format) and PCX (pixel graphics)
data formats for output files which can at a later time be directly integrated in corresponding programs for documentation purposes.

HCOPy:DEVice:PRESet[1|2]

This command resets the hardcopy unit (1 or 2) prior to generating the hardcopy.

Syntax: HCOPy:DEVice:PRESet[1|2] ON|OFF

Example: "HCOP:DEV:PRES2 ON"

Features: *RST value: OFF
SCPI: device-specific

HCOPy:DEVice:RESolution[1|2]

This command controls the resolution of the printout in PCL4 format (hardcopy unit 1 or 2).

Syntax: HCOPy:DEVice:RESolution[1|2] 150 | 300

Example: "HCOP:DEV:RES 300"

Features: *RST value: 150
SCPI: conforming

The resolution for an output in PCL4 format is between 150 dpi or 300 dpi.

HCOPy[:IMMediate[1|2]]

This command starts a hardcopy output.

Syntax: HCOPy[:IMMediate[1|2]]

Example: "HCOP"

Features: *RST value: -
SCPI: conforming

HCOPy:IMM[1] starts the hardcopy output to device 1 (default),
HCOPy:IMM2 starts the output to device 2.
This command is an event which is why it is not assigned an *RST value and has no query.

HCOPy:DEVice:ITEM:ALL

This command selects the complete screen to be output.

Syntax: HCOPy:DEVice:ITEM:ALL

Example: "HCOP:DEV:ITEM:ALL"

Features: *RST value: OFF
SCPI: conforming

The hardcopy output is always provided with comments, title, time and date.

As an alternative to the whole screen, only traces (commands 'HCOPy:DEVice:WINDow:TRACe:STATe ON') or tables (command 'HCOPy:DEVice:WINDow:TABLe:STATe ON') can be output.

HCOPy:DEVice:ITEM:FFEed[1|2]:STATe

The command adds a form feed command to the hardcopy output of the screen.

Syntax: HCOPy:DEVice:ITEM:FFEed[1|2]:STATe ON|OFF

Example: "HCOP:DEV:ITEM:FFE2:STAT ON"

Features: *RST value: OFF
SCPI: conforming

HCOPy:DEVice:ITEM:LABel:TEXT

This command defines the title of the screen.

Syntax: HCOPy:DEVice:ITEM:LABel:TEXT <string>

Example: "HCOP:DEV:ITEM:LAB:TEXT 'My Title'"

Features: *RST value: OFF
SCPI: conforming

HCOPy:DEVice:ITEM:PFEed[1|2]:STATe

This command adds a paper feed command to the hardcopy output of the screen (ON).

Syntax: HCOPy:DEVice:ITEM:PFEed[1|2]:STATe ON|OFF

Example: "HCOP:DEV:ITEM:PFE2:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

HCOPy:DEVice:ITEM:WINDow[1|2]:TABle:STATe

This command selects the output of the currently displayed tables (ON).

Syntax: HCOPy:DEVice:ITEM:WINDow[1|2]:TABle:STATe ON | OFF

Example: "HCOP:DEV:ITEM:WIND:TABL:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

The command HCOPy:DEVice:ITEM:WINDow[1|2]:TABle:STATe OFF same as command HCOPy:DEVice:ITEM:ALL enables the output of the whole screen.

HCOPy:DEVice:ITEM:WINDow[1|2]:TEXT

This command defines the comment text for printout to trace 1 or 2.

Syntax: HCOPy:DEVice:ITEM:WINDow[1|2]:TEXT <string>

Example: "HCOP:DEV:ITEM:WIND2:TEXT 'comment'"

Features: *RST value: -
SCPI: device-specific

HCOPy:DEVice:ITEM:WINDow[1|2]:TRACe:STATe

This command selects the output of the currently displayed trace (ON).

Syntax: HCOPy:DEVice:ITEM:WINDow[1|2]:TRACe:STATe ON | OFF

Example: "HCOP:DEV:ITEM:WIND:TRACe:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

The command HCOPy:DEVice:ITEM:WINDow[1|2]:TRACe:STATe OFF same as command HCOPy:DEVice:ITEM:ALL enables the output of the whole screen.

HCOPy:DEVice:ITEM:WINDow[1|2]:TRACe:CAINcrement

The command automatically changes the colour of the currently displayed trace after printout (ON).

Syntax: HCOPy:DEVice:ITEM:WINDow[1|2]:TRACe:CAINcrement ON | OFF

Example: `"HCOP:DEV:ITEM:WIND:TRACe:CAIN ON"`

Features: *RST value: OFF
SCPI: device-specific

The automatic change of colour of the trace allows outputting to a plotter of several traces of the same diagram. For a better distinction, the colour of the trace is changed ("Color Auto Increment").

HCOPy:PAGE:DIMensions:QUADrant

The command defines the quadrant which is allocated to the screen output.

Syntax: HCOPy:PAGE:DIMensions:QUADrant[1 to 4]

Example: `"HCOP:PAGE:DIM:QUAD1"`

Features: *RST value: -
SCPI: conforming

The quadrants are defined as QUAD1 at the top right, QUAD2 at the top left, QUAD3 at the bottom left and QUAD4 at the bottom right. This command is an event which is why it is not assigned an *RST value and has no query.

HCOPy:PAGE:DIMensions:FULL

This command defines that the full screen is to be printed out.

Syntax: HCOPy:PAGE:DIMensions:FULL

Example: `"HCOP:PAGE:DIM:FULL"`

Featrues: *RST value: -
SCPI: device-specific

This command is an event which is why it is not assigned and *RST value and has no query.

HCOPy:PAGE:ORIentation[1|2]

The command selects the format of the output (portrait and landscape) (hardcopy unit 1 or 2).

Syntax: HCOPy:PAGE:ORIentation[1|2] LANDscape | PORTrait

Example: `"HCOP:PAGE:ORI LAND"`

Features: *RST value: -
SCPI: conforming

3.6.10 INITiate Subsystem

The INITiate subsystem checks the initialization of the trigger subsystem.

COMMAND	PARAMETER	UNIT	COMMENT
INITiate			
:CONTinuous	<boolean>	–	
[:IMMediate]	–	–	no query
:DISPlay	<boolean>	–	

INITiate:CONTinuous

This command determines if the trigger system is continuously initiated ("Free Run").

Syntax: INITiate:CONTinuous ON | OFF

Example: `"INIT:CONT OFF"`

Features: *RST value: ON
SCPI: conforming

Setting "INITiate:CONTinuous ON" corresponds to function SWEEP CONTinuous, ie the sweep of the analyzer is cyclically repeated. The setting "INITiate:CONTinuous OFF" corresponds to function SWEEP SINGLE.

INITiate[:IMMediate]

The command initiates a new sweep or starts a single sweep.

Syntax: INITiate[:IMMediate]

Example: `"INIT"`

Features: *RST value: -
SCPI: conforming

This command is an event which is why it is not assigned an *RST value and has no query.

INITiate:DISPlay

This command switches the display on or off during a single sweep.

Syntax: INITiate:DISPlay ON | OFF

Example: `"INIT:DISP OFF"`

Features: *RST value: ON
SCPI: device-specific

3.6.11 INPut Subsystem

The INPut subsystem checks the input features of the instrument.

COMMAND	PARAMETER	UNIT	COMMENT
INPut			
:ATTenuation	<numeric_value>	DB	
:AUTO	<boolean>	–	
:MODE	NORMal|LNOise|LDIStortion	–	
:UPORt<1|2>			
[:VALue?]	–	–	query only
:STATe	<boolean>	–	

INPut:ATTenuation

This command programs the input attenuator.

Syntax: INPut:ATTenuation <numeric_value>
<numeric_value>::= 0 to 70dB

Example: "INP:ATT 40dB"

Features: *RST value: - (AUTO is set to ON)
SCPI: conforming

The input attenuator can be programmed in steps of 10dB. If the attenuation is directly programmed, the coupling to the reference level is switched off.

INPut:ATTenuation:AUTO

This command automatically couples the input attenuation to the reference level.

Syntax: INPut:ATTenuation:AUTO ON | OFF

Example: "INP:ATT:AUTO ON"

Features: *RST value: ON
SCPI: conforming

INPut:ATTenuation:AUTO:MODE

This command optimizes the coupling of the input attenuation to the reference level to high sensitivity or to high intermodulation immunity.

Syntax: INPut:ATTenuation:AUTO:MODE NORMal | LNOise | LDIStortion

Example: "INP:ATT:AUTO:MODE LDIS"

Features: *RST value: ON
SCPI: device-specific

For LNOise, the input attenuator value is set 10dB lower than for INP:ATT:AUTO:MODE NORMal, for LDIStortion it is set 10dB higher.

INPut:UPORt[1|2][:VALue]?

This command queries the control lines of the user ports.

Syntax: INPut:UPORt[1|2][:VALue]?

Example: "INP:UPOR2?"

Features: *RST value: -
SCPI: device-specific

This command is a query command which is why it is not assigned an *RST value.

INPut:UPORt[1|2]:STATe

This commmand toggles the control lines of the user ports between INPut and OUTPut.

Syntax: INPut:UPORt[1|2]:STATe ON | OFF

Example: "INP:UPOR2:STAT ON"

Features: *RST value: ON
SCPI: device-specific

With ON, the user port is switched to INPut, with OFF to OUTPut.

3.6.12 INSTrument Subsystem

The INSTrument subsystem selects the operating mode of the unit either via text parameters or fixed numbers.

COMMAND	PARAMETER	UNIT	COMMENT
INSTrument<1|2> [:SELect] :NSELect	SANalyzer | DDEMod <numeric_value>		Option FSE-B7

INSTrument[:SELect]

This command switches between the spectrum analyzer and vector analyzer mode by means of text parameters.

Syntax: INSTrument[:SELect] SANalyzer | DDEMod

Example: `"INST DDEM"`

Features: *RST value: SANalyzer
SCPI: conforming

Switchover to DDEMod is only possible in conjunction with Option FSE-B7.

INSTrument:NSELect

This command switches between the two modes by means of numbers.

Syntax: INSTrument:NSELect 1 | 2

Example: `"INST:NSEL 2"`

Features: *RST value: 1
SCPI: conforming

Value 1 corresponds to SANalyzer, value 2 corresponds to DDEMod of the command INSTrument[:SELect].

3.6.13 MMEMory Subsystem

The MMEMory (mass memory) subsystem provides commands which allow for access to the storage media of the instrument and for storing and loading various instrument settings.
The NAMe command stores the HCOPy outputs in a file.
The various drives can be addressed via the mass storage unit specifier <msus> using the conventional DOS syntax. The internal hard disk is addressed by "C:", the floppy-disk drive installed by "A:".
The file names <file_name> are indicated as string parameters with the commands being enclosed in quotation marks. They correspond to the DOS conventions.
DOS file names consist of max. 8 ASCII characters and an extension of up to three characters separated from the file name by a colon "." Both, the colon and the extension are optional. The colon is not part of the file name. DOS file names do not differ between uppercase and lowercase notation. All letters and digits are permitted as well as the special characters "_", "^", "$", "~", "!", "#", "%", "&", "-", "{", "}", "(", ")", "@" and "`". Reserved file names are CLOCK$, CON, AUX, COM1 to COM4, LPT1 to LPT3, NUL and PRN.
The two characters "*" and "?" have the function of so-called "wildcards", i.e., they are variables for selection of several files. The question mark "?" replaces exactly one character which may be any, the asterisk means any of the remaining characters in the file name. "*.*" thus means all files in a directory.

COMMAND	PARAMETER	UNIT	COMMENT
MMEMory			
:CDIRectory	<directory_name>	--	
:COPY	<file_name>,<file_name>	--	no query
:DELete	<file_name>	--	no query
:INITialize	<msus>	--	no query
:LOAD			
:STATe	1,<file_name>	--	
:MDIRectory	<directory_name>	--	no query
:MOVE	<file_name>,<file_name>	--	no query
:MSIS	<msus>	--	
:NAME	<file_name>	--	
:RDIRectory	<directory_name>	--	no query
:STORe			
:STATe	1,<file_name>	--	

MMEMory:CDIRectory

This command changes the current directory.

Syntax: MMEMory:CDIRectory <directory_name>
<directory_name>::= DOS path name

Example: "MMEM:CDIR 'C:\USER\DATA'"

Features: *RST value: -
SCPI: conforming

In addition to the path name, the indication of the directory may contain the drive name. The path name complies with the DOS conventions.

MMEMory:COPY

This command copies the files indicated.

Syntax: MMEMory:COPY <file_source>,<file_destination>
<file_source>,<file_destination> ::= <file_name>
<file_name> ::= DOS file name

Example: "MMEM:COPY 'C:\USER\DATA\SETUP.CFG','A:'"

Features: *RST value: -
SCPI: conforming

The indication of the file name may include the path and the drive. The file names and path information must be in accordance with the DOS conventions. This command is an event which is why it is not assigned an *RST value and has no query.

MMEMory:DELete

This command deletes the files indicated.

Syntax: MMEMory:DELete <file_name>
<file_name> ::= DOS file name

Example: "MMEM:DEL 'TEST01.HCP'"

Features: *RST value: -
SCPI: conforming

The indication of the file name contains the path and, optionally, the drive. Indication of the path corresponds to the DOS conventions. The file name includes indication of the path and may also include the drive. The path name corresponds to the DOS conventions. This command is an event which is why it is not assigned an *RST value and has no query.

MMEMory:INITialize

This command formats the disk in drive A.

Syntax: MMEMory:INITialize <msus>
<msus> ::= 'A:'

Example: "MMEM:INIT 'A:'"

Features: *RST value: -
SCPI: conforming

Formatting deletes all data stored on the floppy disk. This command is an event which is why it is not assigned an *RST value and has no query.

MMEMory:LOAD:STATe

This command loads instrument settings from files.

Syntax: MMEMory:LOAD:STATe 1,<file_name>
<file_name> ::= DOS file name

Example: "MMEM:LOAD:STAT 1,'A:TEST.CFG'"

Features: *RST value: -
SCPI: conforming

The contents of the file is loaded and set as new instrument state. The file name includes indication of the path and may also include the drive. The path name corresponds to the DOS conventions. This command is an event which is why it is not assigned an *RST value and has no query.

MMEMory:MDIRectory

This command creates a new directory.

Syntax: MMEMory:MDIRectory <directory_name>
<directory_name>::= DOS path name

Example: "MMEM:MDIR 'C:\USER\DATA'"

Features: *RST value: -
SCPI: device-specific

The file name includes indication of the path and may also include the drive. The path name corresponds to the DOS conventions. This command is an event which is why it is not assigned an *RST value and has no query.

MMEMory:MOVE

This command renames existing files.

Syntax: MMEMory:MOVE <file_source>,<file_destination>
<file_source>,<file_destination> ::= <file_name>
<file_name> ::= DOS file name

Example: "MMEM:MOVE 'TEST01.CFG','SETUP.CFG'"

Features: *RST value: -
SCPI: conforming

The file name includes indication of the path and may also include the drive. The path name corresponds to the DOS conventions. This command is an event which is why it is not assigned an *RST value and has no query.

MMEMory:MSIS

This command changes to the drive indicated.

Syntax: MMEMory:MSIS <device>
<device>::= 'A:' | 'C:'

Example: "MMEM:MSIS 'A:'"

Features: *RST value: 'C:'
SCPI: conforming

The drive may be the internal hard disk C: or the floppy-disk drive A:. The drive is indicated according to the DOS conventions.

MMEMory:NAME

This command specifies a file which is printed or plotted to.

Syntax: MMEMory:NAME <file_name>
<file_name> ::= DOS filename

Example: "MMEM:NAME 'PLOT1.HPG'"

Features: *RST value: -
SCPI: conforming

The file name includes indication of the path and may also include the drive. The file name and path information correspond to the DOS conventions. The output to the printer is routed into a file using the command "HCOP:DEST 'MMEM'".

MMEMory:RDIRectory

This command deletes the directory indicated.

Syntax: MMEMory:RDIRectory <directory_name>
<directory_name>::= DOS path name

Example: "MMEM:RDIR 'C:\TEST'"

Features: *RST value: -
SCPI: device-specific

The directory name includes indication of the path and may also include the drive. The path name corresponds to the DOS conventions. This command is an event which is why it is not assigned an *RST value and has no query.

MMEMory:STORe:STATe

This command stores the current instrument setting in a file.

Syntax: MMEMory:STORe:STATe 1,<file_name>
<file_name> ::= DOS file name

Example: "MMEM:STOR:STAT 1,'TEST.CFG'"

Features: *RST value: -
SCPI: conforming

The current instrument state is stored as a file. The file name includes indication of the path and may also include the drive. The path name corresponds to the DOS conventions. This command is an event which is why it is not assigned an *RST value and has no query.

3.6.14 OUTPut Subsystem

Das OUTPut subsystem checks the output features of the instrument.

COMMAND	PARAMETER	UNIT	COMMENT
OUTPut			
:UPORt<1|2>			
[:VALue]	<binary>	-	
:STATe	<boolean>	-	

OUTPut:UPORt[1|2][:VALue

This command sets the control lines of the user ports.

Syntax: OUTPut:UPORt[1|2][:VALue] <Binary>
<Binary>::= 00000000 to 11111111

Example: "OUTP:UPOR2 10100101"

Features: *RST value: -
SCPI: device-specific

User port 1 or 2 is written with the given binary pattern. If the user port is programmed to INPut instead of OUTPut, the output value is temporarily stored.

OUTPut:UPORt[1|2]:STATe

This command toggles the control lines of the user ports between INPut and OUTPut.

Syntax: OUTPut:UPORt[1|2]:STATe ON | OFF

Example: "OUTP:UPOR:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

With ON, the user port is switched to OUTPut, with OFF to INPut.

3.6.15 SENSe Subsystem

The SENSe subsystem is itself divided up into several subsystems. The commands of these subsystems directly control device-specific settings, they do not refer to the signal characteristics of the measurement signal.
The SENSe subsystem controls the essential parameters of the analyzer. In accordance with the SCPI standard, it is for this reason optional, which means that it is not necessary to include the SENSe node in command sequences.

3.6.15.1 [SENSe]:AVERage Subsystem

The [SENSe]:AVERage subsystem calculates the average of the data acquired. A new test result is obtained from various successive measurements. The amount of test points and the axis reference of the new result correspond to those of the original measurements.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe]			
:AVERage			
:COUNt	<numeric_value>	–	
:AUTO	<Boolean>	–	
[:STATe]	<Boolean>	–	
:TYPE	MAXimum | SCALar	–	

[SENSe]:AVERage:COUNt

The command specifies the number of measurements which are combined.

Syntax: [SENSe]:AVERage:COUNt <numeric_value>
<numeric value> ::= 0 to 256

Example: ":AVER:COUN 16"

Features: *RST value: 0
SCPI: conforming

[SENSe]:AVERage:COUNt:AUTO

AUTO ON selects a suitable number of :COUNt for the respective type of measurement.

Syntax: [SENSe]:AVERage:COUNt:AUTO ON | OFF

Example: ":AVER:COUN:AUTO ON"

Features: *RST value: OFF
SCPI: conforming

[SENSe]:AVERage[:STATe]

The command switches on or off the average function.

Syntax: [SENSe]:AVERage[:STATe] ON | OFF

Example: ":AVER OFF"

Features: *RST value: OFF
SCPI: conforming

[SENSe]:AVERage:TYPE

The command selects the type of average function.

Syntax: [SENSe]:AVERage:TYPE MAXimum | SCALar

Example: ":AVER:TYPE SCAL"

Features: *RST value: SCALar
SCPI: conforming

The following average functions have been defined:

MAXimum: $AVG(n) = MAX(X_1 \text{ to } .X_n)$

SCALar: $$AVG(n)=\frac{1}{n}\times \sum_{i=1}^{n} xi$$

3.6.15.2 SENSe:BANDwidth Subsystem

This subsystem controls the setting of the analyzer's filter bandwidths. Both groups of commands (BANDwidth and BWIDth) perform the same functions.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe]			
:BANDwidth			
[:RESolution]	<numeric_value>	HZ	
:AUTO	<Boolean>	--	
:MODE	ANALog | DIGital		
:VIDeo	<numeric_value>	HZ	
:AUTO	<Boolean>	--	
:BWIDth			
[:RESolution]	<numeric_value>	HZ	
:AUTO	<Boolean>	--	
:MODE	ANALog | DIGital		
:VIDeo	<numeric_value>	HZ	
:AUTO	<Boolean>	--	

[SENSe:]BANDwidth\|BWIDth[:RESolution]

This command defines the analyzer's resolution bandwidth.

Syntax: [SENSe:]BANDwidth|BWIDth[:RESolution] <numeric_value>
<numeric_value>::= 10Hz to 10MHz (model 20)
1HZ to 10MHz (model 30)

Example: "BAND 1MHz"

Features: *RST value: - (AUTO is set to ON)
SCPI: conforming

The values for the resolution bandwidth are rounded in 1 | 2 | 3 | 5 steps. Bandwidths >1kHz are always analog bandwidths, bandwidths <1kHz are always realized digitally. For the bandwidth 1kHz, it is possible to select either analog or digital filters.

[SENSe:]BANDwidth\|BWIDth[:RESolution]:AUTO

This command either automatically couples the resolution bandwidth of the analyzer to the span or cancels the coupling.

Syntax: [SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO ON | OFF

Example: "BAND:AUTO OFF"

Features: *RST value: ON
SCPI: conforming

The automatic coupling matches the resolution bandwidth to the currently set span according to the relationship between span and resolution bandwidth.

[SENSe:]BANDwidth|BWIDth[:RESolution]:MODE

This command toggles between analog and digital resolution filters for the 1-kHz bandwidth.

Syntax: [SENSe:]BANDwidth|BWIDth[:RESolution]:MODE ANALog | DIGital

Example: "BAND:MODE DIG"

Features: *RST value: ANALog
SCPI: device-specific

Depending on the bandwidth, the resolution filters are automatically toggled between digital filters (<1kHz) and analog filters (>1kHz). The 1-kHz bandwidth is present in the instrument as a digital filter and as an analog filter and can be toggled using this command.

[SENSe:]BANDwidth|BWIDth:VIDeo

This command defines the analyzer's video bandwidth.

Syntax: [SENSe:]BANDwidth|BWIDth:VIDeo <numeric_value>
<numeric_value>::= 1Hz to 10MHz

Example: "BAND:VID 10kHz"

Features: *RST value: - (AUTO is set to ON)
SCPI: conforming

The values for the video bandwidth are rounded in 1 | 2 | 3 | 5 steps.

[SENSe:]BANDwidth|BWIDth:VIDeo:AUTO

This command either automatically couples the analyzer's video bandwidth to the resolution bandwidth or cancels the coupling.

Syntax: [SENSe:]BANDwidth|BWIDth:VIDeo:AUTO ON | OFF

Example: "BAND:VID:AUTO OFF"

Features: *RST value: ON
SCPI: conforming

3.6.15.3 SENSe:DETector Subsystem

The SENSe:DETector subsystem controls the recording of measurement values via the type of detector selected for each trace.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe] :DETector [:FUNCtion] :AUTO	NEGative| POSitive | SAMPle| APEak <Boolean>	-	

[SENSe:]DETector[:FUNCtion]

This command switches the detector for recording of the measured value.

Syntax: [SENSe:]DETector[:FUNCtion] NEGative | POSitive | SAMPle | APEak

Example: "DET POS"

Features: *RST value: APEak
SCPI: conforming

The value "APEak" (AutoPeak) displays both the postive peak value and the negative peak value when noise is present. The positive peak value is displayed when one signal is present.

[SENSe:]DETector[:FUNCtion]:AUTO

This command either couples the detector to the current trace setting or turns coupling off.

Syntax: [SENSe:]DETector[:FUNCtion]:AUTO ON | OFF

Example: "DET:AUTO OFF"

Features: *RST value: ON
SCPI: conforming

3.6.15.4 SENSe:DDEMod Subsystem

This subsystem controls the parameters for digital demodulation and is only active in conjunction with Option FSE-B7.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe]			
:DDEMod			Option FSE-B7
:FORMat	QPSK | PSK | MSK		
:QPSK			
:FORMat	NORMal | DIFFerential | DPI4		
:PSK			
NSTate	2 | 8		
:MSK			
:FORMat	TYPE1 | TYPE2		
:SRATe	<numeric_value>	HZ	
:TIMe	<numeric_value>	SYM	
:PRATe	1 | 2 | 4 | 8 | 16		
:FILTer			
:MEASurement	OFF | RCOSine | RRCosine | GAUSsian		
:REFerence	OFF | RCOSine | RRCosine | GAUSsian		
:ALPHa	<numeric_value>		
:NORMalize	<Boolean>		
:PRESet	GSM | NADC | TETRa | DCS1800 | PCS1900 | PHS | PDC | CDPD		
:SEARch			
:PULSe			
:STATe	<Boolean>		
:SYNC			
:OFFSet	<numeric_value>	SYM	
:PATTern	<string>		
:STATe	<Boolean>		
:TIME	100 | 200 | 400 | 800	SYM	
:TCAPture			Option FSE-B7
:LENGth	<numeric_value>		

[SENSe:]DDEMod:FORMat

This command selects the digital demodulation type.

Syntax: [SENSe:]DDEMod:FORMat QPSK | PSK | MSK

Example: "DDEM:FORM QPSK"

Features: *RST value: MSK
SCPI: device-specific

[SENSe:]DDEMod:QPSK:FORMat:

This command determines the specific demodulation type for QPSK.

Syntax: [SENSe:]DDEMod:QPSK:FORMat NORMal | DIFFerential | DPI4

Example: "DDEM:QPSK:FORM DPI4"

Features: *RST value: -
SCPI: device-specific

[SENSe:]DDEMod:PSK:NSTate

This command determines the specific demodulation type for PSK.

Syntax: [SENSe:]DDEMod:PSK:NSTate 2 | 8

Example: "DDEM:PSK:NST 2"

Features: *RST value: -
SCPI: device-specific

Value 2 (ie PSK2) corresponds to BPSK demodulation, value 8 the 8PSK demodulation.

[SENSe:]DDEMod:MSK:FORMat

This command determines the specific demodulation type for MSK.

Syntax: [SENSe:]DDEMod:MSK:FORMat TYPE1 | TYPE2

Example: "DDEM:MSK:FORM TYPE2"

Features: *RST value: TYPE2
SCPI: device-specific

TYPE1 corresponds to MSK demodulation, TYPE2 corresponds to DMSK demodulation

[SENSe:]DDEMod:SRATe

This command defines the symbol rate.

Syntax: [SENSe:]DDEMod:SRATe <numeric_value>
<numeric value> ::= 160 Hz to 1.6 MHz

Example: "DDEM:SRAT 18kHz"

Features: *RST value: 270.833333kHz
SCPI: device-specific

[SENSe:]DDEMod:TIME

The command determines the number of displayed symbols (result length).

Syntax: [SENSe:]DDEMod:TIME <numeric_value>
<numeric value> ::= 1 to Frame Length

Example: "DDEM:TIME 80"

Features: *RST value: 147
SCPI: device-specific

[SENSe:]DDEMod:PRATe

This command determines the number of points per symbol.

Syntax: [SENSe:]DDEMod:PRATe 1 | 2 | 4 | 8 | 16

Example: "DDEM:PRAT 8"

Features: *RST value: 4
SCPI: device-specific

[SENSe:]DDEMod:FILTer:MEASurement

This command selects the input filter for the test signal.

Syntax: [SENSe:]DDEMod:FILTer:MEASurement
OFF | RCOSine | RRCosine | GAUSsian

Example: "DDEM:FILT:MEAS RCOS"

Features: *RST value: OFF
SCPI: device-specific

[SENSe:]DDEMod:FILTer:REFerence

This command selects the input filter for the reference signal.

Syntax: [SENSe:]DDEMod:FILTer:REFerence
OFF | RCOSine | RRCosine | GAUSsian

Example: "DDEM:FILT:REF RCOS"

Features: *RST value: GAUSsian
SCPI: device-specific

[SENSe:]DDEMod:FILTer:ALPHa

This command determines the filter characteristic (ALPHA/BT).

Syntax: [SENSe:]DDEMod:FILTer:ALPHa <numeric_value>
<numeric_value>::= 0.2 to 1 (stepwidth 0.05)

Example: "DDEM:FILT:ALPH 0.5"

Features: *RST value: 0.3
SCPI: device-specific

[SENSe:]DDEMod:NORMalize

This command switches normalizing of the unit circle on or off using IQ offset.

Syntax: [SENSe:]DDEMod:NORMalize ON | OFF

Example: "DDEM:NORM OFF"

Features: *RST value: ON
SCPI: device-specific

[SENSe:]DDEMod:SEARch:PULSe:STATe

This command switches the signal burst search on or off.

Syntax: [SENSe:]DDEMod:SEARch:PULSe:STATe ON | OFF

Example: "DDEM:SEAR:PULS:STAT OFF"

Features: *RST value: ON
SCPI: device-specific

[SENSe:]DDEMod:SEARch:SYNC:OFFSet

This command defines the offset of the display with reference to the sychronization sequence.

Syntax: [SENSe:]DDEMod:SEARch:SYNC:OFFSET <numeric_value>

Example: "DDEM:SEAR:SYNC:OFFS 10SYM"

Features: *RST value: 0 SYM
SCPI: device-specific

[SENSe:]DDEMod:SEARch:SYNC:PATTern

This command defines the synchronization sequence.

Syntax: [SENSe:]DDEMod:SEARch:SYNC:PATTern <string>

Example: "DDEM:SEAR:SYNC:PATT "1101001"

Features: *RST value: ""
SCPI: device-specific

[SENSe:]DDEMod:SEARch:SYNC:STATe

This command switches the search for a synchronization sequence on or off.

Syntax: [SENSe:]DDEMod:SEARch:SYNC:STATe ON | OFF

Example: "DDEM:SEARch:SYNC:STAT ON"

Features: *RST value: OFF
SCPI: device-specific

[SENSe:]DDEMod:SEARch:TIME

This command determines the number of symols required for demodulation (frame length). The value 800 is only permissible if the number of points per symbol is <16.

Syntax: [SENSe:]DDEMod:SEARch:TIME 100 | 200 | 400 | 800

Example: "DDEM:SEAR:TIME 800"

Features: *RST value: 200
SCPI: device-specific

[SENSe:]DDEMod:PRESet

This command selects an automatic setting of all modulation parameters according to a standard transmission method.

Syntax: [SENSe:]DDEMod:PRESet GSM | NADC | TETRa | DCS1800 | PCS1900 | PHS | PDC | CDPD

Example: "DDEM:PRES TETR"

Features: *RST value: GSM
SCPI: device-specific

[SENSe:]TCAPture:LENGth

This command determines the number of sampling points that are written into the memory for each measurement (memory size).

Syntax: [SENSe:]TCAPture:LENGth 1024 | 2048 | 4096 | 8192 | 16384

Example: "TCAP:LENG 1024"

Features: *RST value: 16384
SCPI: device-specific

3.6.15.5 SENSe:FREQuency Subsystem

The SENSe:FREQuency subsystem defines the frequency axis of the active display. The frequency axis can either be defined via the start/stop frequency or via the center frequency and span.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe]			
:FREQuency			
:CENTer	<numeric_value>	HZ	
:LINK	STARt | STOP | SPAN	--	
:STEP	<numeric_value>	HZ	
:LINK	SPAN | RBW	--	
:FACTor	<numeric_value>	--	
:SPAN	<numeric_value>	HZ	
:FULL	--	--	
:LINK	CENTer | STARt | STOP	--	
:STARt	<numeric_value>	HZ	
:LINK	CENTer | STOP | SPAN	--	
:STOP	<numeric_value>	HZ	
:LINK	CENTer | STAR t ISPAN	--	

[SENSe:]FREQuency:CENTer

This command defines the center frequency of the analyzer.

Syntax: [SENSe:]FREQuency:CENTer <numeric_value>
<numeric_value>::= 0 GHz to f_{max}

Example: "FREQ:CENT 100MHz"

Features: *RST value: 0 GHz to f_{max} / 2
SCPI: conforming

The automatic coupling of the parameters is set to SPAN FIXED.

[SENSe:]FREQuency:CENTer:LINK

This command defines the coupling of the center frequency to the start, stop frequency or the frequency span.

Syntax: [SENSe:]FREQuency:CENTer:LINK STARt | STOP | SPAN

Example: "FREQ:CENT:LINK STAR"

Features: *RST value: SPAN
SCPI: device-specific

[SENSe:]FREQuency:CENTer:STEP

This command defines the stepwidth of the center frequency.

Syntax: [SENSe:]FREQuency:CENTer:STEP <numeric_value>
<numeric_value>::= 0 to f_{max}

Example: "FREQ:CENT:STEP 120MHz"

Features: *RST value: - (AUTO 0.1 × SPAN is switched on)
SCPI: conforming

[SENSe:]FREQuency:CENTer:STEP:LINK

This command couples the stepwidth of the center frequency to span (span >0) or to the resolution bandwidth (span = 0).

Syntax: [SENSe:]FREQuency:CENTer:STEP:LINK SPAN | RBW

Example: "FREQ:CENT:STEP:LINK SPAN"

Features: *RST value: SPAN
SCPI: device-specific

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor

This command couples the stepwidth of the center frequency with a factor to the span (span >0) or to the resolution bandwidth (span = 0).

Syntax: [SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <numeric_value>
<numeric_value>::= 1 to 100 PCT

Example: "FREQ:CENT:STEP:LINK:FACT 20PCT"

Features: *RST value: - (AUTO 0.1 × SPAN is switched on)
SCPI: device-specific

[SENSe:]FREQuency:SPAN

This command defines the frequency span of the analyzer.

Syntax: [SENSe:]FREQuency:SPAN <numeric_value>
<numeric_value>::= 0 GHz to f_{max}

Example: "FREQ:SPAN 10MHz"

Features: *RST value: f_{max}
SCPI: conforming

The automatic coupling of the parameters is set to CENTER FIXED.

[SENSe:]FREQuency:SPAN:FULL

This command sets the maximum frequency span of the analyzer.

Syntax: [SENSe:]FREQuency:SPAN:FULL

Example: "FREQ:SPAN:FULL"

Features: *RST value: -
SCPI: conforming

This command is an event which is why it is not assigned an *RST value and has no query.

[SENSe:]FREQuency:SPAN:LINK

This command defines the coupling for frequency-span changes.

Syntax: [SENSe:]FREQuency:SPAN:LINK CENTer | START | STOP

Example: "FREQ:SPAN:LINK STOP"

Features: *RST value: CENTer
SCPI: conforming

[SENSe:]FREQuency:STARt

This command defines the start frequency of the analyzer.

Syntax: [SENSe:]FREQuency:STARt <numeric_value>
<numeric_value>::= 0 GHz to f_{max}

Example: "FREQ:STAR 20MHz"

Features: *RST value: 0
SCPI: conforming

The automatic coupling of the parameters is set to STOP FIXED.

[SENSe:]FREQuency:STARt:LINK

This command defines the coupling for start-frequency changes.

Syntax: [SENSe:]FREQuency:STARt:LINK CENTer | STOP | SPAN

Example: "FREQ:STAR:LINK SPAN"

Features: *RST value: STOP
SCPI: device-specific

[SENSe:]FREQuency:STOP

This command defines the stop frequency of the analyzer.

Syntax: [SENSe:]FREQuency:STOP <numeric_value>
<numeric_value>::= 0 GHz to f_{max}

Example: "FREQ:STOP 2000MHz"

Features: *RST value: f_{max}
SCPI: conforming

The automatic coupling of the parameters is set to STARt FIXED.

[SENSe:]FREQuency:STOP:LINK

This command defines the coupling for stop-frequency changes.

Syntax: [SENSe:]FREQuency:STOP:LINK CENTer | STARt | SPAN

Example: "FREQ:STOP:LINK SPAN"

Features: *RST value: STARt
SCPI: device-specific

3.6.15.6 SENSe:ROSCillator Subsystem

This subsystem controls the reference oscillator.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe]			
:ROSCillator			
:SOURce	INTernal | EXTernal	--	
:EXTernal			
:FREQuency	<numeric_value>	HZ	

[SENSe:]ROSCillator:SOURce

This command controls selection of the reference oscillator.

Syntax: [SENSe:]ROSCillator:SOURce INTernal | EXTernal

Example: `"ROSC:SOUR EXT"`

Features: *RST value: INTernal
SCPI: conforming

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

[SENSe:]ROSCillator:EXTernal:FREQuency

This command defines the frequency of the external reference oscillator.

Syntax: [SENSe:]ROSCillator:EXTernal:FREQuency <numeric_value>
<numeric_value>::= 1MHz to 16MHz

Example: `"ROSC:EXT:FREQ 5MHz"`

Features: *RST value: 10MHz
SCPI: conforming

The value of the external reference frequency (1MHz to 16MHz) is rounded in steps of 1MHz.

3.6.15.7 SENSe:SWEep Subsystem

This subsystem controls the sweep parameters.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe]			
:SWEep			
:TIME	<numeric_value>	S	
:AUTO	<Boolean>	–	
:COUNt	<numeric_value>	–	
:EGATe	<Boolean>	–	
:LEVel	<numeric_value>	V	
:TYPE	LEVel|EDGE	–	
:POLarity	POSitive|NEGative	–	
:HOLDoff	<numeric_value>	S	
:LENGth	<numeric_value>	S	
:GAP	<Boolean>	–	
:PRETrigger	<numeric_value>	S	
:TRGTogap	<numeric_value>	S	
:LENGth	<numeric_value>	S	

[SENSe:]SWEep:TIME

This command defines the duration of the sweep.

Syntax: [SENSe:]SWEep:TIME <numeric_value>
<numeric_value>::= 5ms to 1000s

Example: `"SWE:TIME 10s"`

Features: *RST value - (AUTO is set to ON)
SCPI: conforming

If SWEep:TIME is directly programmed, automatic coupling is switched off.

[SENSe:]SWEep:TIME:AUTO

This command switches the automatic coupling of the sweep time for the frequency span or bandwidth settings.

Syntax: [SENSe:]SWEep:TIME:AUTO ON | OFF

Example: `"SWE:TIME:AUTO ON"`

Features: *RST value: ON
SCPI: conforming

If SWEep:TIME is directly programmed, automatic coupling is switched off.

[SENSe:]SWEep:COUNt

This command defines the number of sweeps started with single sweep.

Syntax: [SENSe:]SWEep:COUNt <numeric_value>
<numeric_value>::= 0 to 32767

Example: "SWE:COUNT 64"

Features: *RST value: 0
SCPI: conforming

This parameter defines the number of sweeps or the number of averagings. In the average mode, the value 0 defines a running averaging of measurement data over 10 sweeps.

[SENSe:]SWEep:EGATe

This command controls the sweep with the external gate signal.

Syntax: [SENSe:]SWEep:EGATe ON | OFF

Example: "SWE:EGAT ON"

Features: *RST value: OFF
SCPI: device-specific

[SENSe:]SWEep:EGATe:LEVel

This command determines the threshold for the extenal gate signal.

Syntax: [SENSe:]SWEep:EGATe:LEVel <numeric_value>
<numeric_value>::= -5V to +5V

Example: "SWE:EGAT:LEV 3V"

Features: *RST value: 2V
SCPI: device-specific

If SWEep:TIME is directly programmed, automatic coupling is switched off.

[SENSe:]SWEep:EGATe:TYPE

This command sets the type of triggering (level or edge) by the external gate signal.

Syntax: [SENSe:]SWEep:EGATe:TYPE LEVel | EDGE

Example: "SWE:EGAT:TYPE EDGE"

Features: *RST value: LEVel
SCPI: device-specific

Parameter EGATe:LENGth is not used for level triggering.

[SENSe:]SWEep:EGATe:POLarity

This command determines the polarity of the external gate signal.

Syntax: [SENSe:]SWEep:EGATe:POLarity POSitive | NEGative

Example: "SWE:EGAT:POL POS"

Features: *RST value: NEGative
SCPI: device-specific

[SENSe:]SWEep:EGATe:HOLDoff

This command defines the delay time between the external gate signal and the continuation of the sweep.

Syntax: [SENSe:]SWEep:EGATe:HOLDoff <numeric_value>
<numeric_value>::= 0 to 100s

Example: "SWE:EGAT:HOLD 100us"

Features: *RST value: 0s
SCPI: device-specific

The values for the delay time can be set in steps 1, 2, 3 and 5.

[SENSe:]SWEep:EGATe:LENGth

In case of edge triggering, this command determines the time interval in which the analyzer sweeps.

Syntax: [SENSe:]SWEep:EGATe:LENGth <numeric_value>
<numeric_value>::= 0 to 100s

Example: "SWE:EGAT:LENG 10ms"

Features: *RST value: 0s
SCPI: device-specific

The values for the delay time can be set in steps 1, 2, 3 and 5.

[SENSe:]SWEep:GAP

This command controls the operating mode GAP SWEEP.

Syntax: [SENSe:]SWEep:GAP ON | OFF

Example: "SWE:GAP ON"

Features: *RST value: OFF
SCPI: device-specific

Operating mode GAP SWEEP for measurements in the time domain controls the display of measured values. Measured values can be blanked for a defined time range (GAP).

[SENSe:]SWEep:GAP:PRETrigger

This command defines the evaluation time for measured values before the pretrigger time.

Syntax: [SENSe:]SWEep:GAP:PRETrigger <numeric_value>
<numeric_value>::= 0 to 100s

Example: "SWE:GAP:PRET 100us"

Features: *RST value: 0s
SCPI: device-specific

The pretrigger time can be programmed from 0 to 100s with a resolution of max. 50 ns.

[SENSe:]SWEep:GAP:TRGTogap

This command defines the time between the pretrigger time and the beginning of the gap (trigger-to-gap time)

Syntax: [SENSe:]SWEep:GAP:TRGTogap <numeric_value>
<numeric_value>::= 0 to 100s

Example: "SWE:GAP:TRGT 50us"

Features: *RST value: 0s
SCPI: device-specific

The TRIGGER-TO-GAP time can be programmed from 0 to 100s with a resolution of max. 50 ns.

[SENSe:]SWEep:GAP:LENGth

This command defines the gap length.

Syntax: [SENSe:]SWEep:GAP:LENGth <numeric_value>
<numeric_value>::= 0 to 100s

Example: "SWE:GAP:LENG 400us"

Features: *RST value: 0s
SCPI: device-specific

The gap length can be programmed from 0 to 100s in steps of 1, 2, 3 and 5.

3.6.16 STATus Subsystem

The STATus subsystem contains the commands for the status-reporting system (see Section 3.8, Status Reporting System"). *RST does not influence the status registers.

COMMAND	PARAMETER	UNIT	COMMENT
STATus			
:OPERation			
[:EVENt?]	–	–	
:CONDition?	–	–	
:ENABle	0 to 65535	–	
:PTRansition	0 to 65535	–	
:NTRansition	0 to 65535	–	
:PRESet	–	–	
:QUEStionable			
[:EVENt?]	–	–	
:CONDition?	–	–	
:ENABle	0 to 65535	–	
:PTRansition	0 to 65535	–	
:NTRansition	0 to 65535	–	
:POWer			
[:EVENt?]	–	–	
:CONDition?	–	–	
:ENABle	0 to 65535	–	
:PTRansition	0 to 65535	–	
:NTRansition	0 to 65535	–	
:LIMit			
[:EVENt?]	–	–	
:CONDition?	–	–	
:ENABle	0 to 65535	–	
:PTRansition	0 to 65535	–	
:NTRansition	0 to 65535	–	
:LMARgin			
[:EVENt?]	–	–	
:CONDition?	–	–	
:ENABle	0 to 65535	–	
:PTRansition	0 to 65535	–	
:NTRansition	0 to 65535	–	
:SYNC			
[:EVENt?]	–	–	
:CONDition?	–	–	
:ENABle	0 to 65535	–	
:PTRansition	0 to 65535	–	
:NTRansition	0 to 65535	–	
:QUEue?	–	–	
[:NEXT?]	–	–	

STATus:OPERation[:EVENt?]

This command queries the contents of the EVENt section of the STATus:OPERation register.

Syntax: STATus:OPERation[:EVENt?]

Example: "STAT:OPER?"

Features: *RST value: –
SCPI: conforming

The contents of the EVENt section is deleted with readout.

STATus:OPERation:CONDition?

This command queries the CONDition section of the STATus:OPERation register.

Syntax: STATus:OPERation:CONDition?

Example: "STAT:OPER:COND?"

Features: *RST value: –
SCPI: conforming

Readout does not delete the contents of the CONDition section. The value returned reflects the current hardware status.

STATus:OPERation:ENABle

This command sets the bits of the ENABle section of the STATus:QUEStionable register.

Syntax: STATus:OPERation:ENABle 0 to 65535

Example: "STAT:OPER:ENAB 65535"

Features: *RST value: –
SCPI: conforming

The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

STATus:OPERation:PTRansition

This command sets the edge detectors of all bits of the STATus:OPERation register from 0 to 1 for the transitions of the CONDition bit.

Syntax: STATus:OPERation:PTRansition 0 to 65535

Example: "STAT:OPER:PTR 65535"

Features: *RST value: –
SCPI: conforming

STATus:OPERation:NTRansition

This command sets the edge detectors of all bits of the STATus:OPERation register from 1 to 0 for the transitions of the CONDition bit.

Syntax: STATus:OPERation:NTRansition 0 to 65535

Example: "STAT:OPER:NTR 65535"

Features: *RST value: –
SCPI: conforming

STATus:PRESet

This command resets the edge detectors and ENABle parts of all registers to a defined value. All PTRansition parts are set to FFFFh, i.e., all transitions from 0 to 1 are detected. All NTRansition parts are set to 0, i.e., a transition from 1 to 0 in a CONDition bit is not detected. The ENABle part of the STATus:OPERation and STATus:QUEStionable registers are set to 0, i.e., all events in these registers are not passed on.

Syntax: STATus:PRESet

Example: `"STAT:PRES"`

Features: *RST value: –
SCPI: conforming

STATus:QUEStionable[:EVENt?]

This command queries the contents of the EVENt section of the STATus:QUEStionable register.

Syntax: STATus:QUEStionable[:EVENt?]

Example: `"STAT:QUES?"`

Features: *RST value: –
SCPI: conforming

Readout deletes the contents of the EVENt section.

STATus:QUEStionable:CONDition?

This command queries the CONDition section of the STATus:QUEStionable register.

Syntax: STATus:QUEStionable:CONDition?

Example: `"STAT:QUES:COND?"`

Features: *RST value: –
SCPI: conforming

Readout does not delete the contents of the CONDition section.

STATus:QUEStionable:ENABle

This command sets the bits of the ENABle section of the STATus-QUEStionable register.

Syntax: STATus:QUEStionable:ENABle 0 to 65535

Example: `"STAT:QUES:ENAB 65535"`

Features: *RST value: –
SCPI: conforming

The ENABle register selectively enables the individual events of the associated EVENt section for the sum bit in the status byte.

STATus:QUEStionable:PTRansition

This command sets the edge detectors of all bits of the STATus:OPERation register from 0 to 1 for the transitions of the CONDition bit.

Syntax: STATus:QUEStionable:PTRansition 0 to 65535

Example: `"STAT:QUES:PTR 65535"`

Features: *RST value: –
SCPI: conforming

STATus:QUEStionable:NTRansition

This command sets the edge detectors of all bits of the STATus:OPERation register from 1 to 0 for the transitions of the CONDition bit.

Syntax: STATus:QUEStionable:NTRansition 0 to 65535

Example: `"STAT:QUES:NTR 65535"`

Features: *RST value: –
SCPI: conforming

STATus:QUEue[:NEXT?]

This command queries the earliest entry to the error queue, thus deleting it.

Syntax: STATus:QUEue[:NEXT?]

Example: `"STAT:QUE?"`

Features: *RST value: –
SCPI: conforming

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI (cf. Appendix B). If the error queue is empty, the error number 0, "no error", is returned. This command is identical with the command `SYSTem:ERRor`.

3.6.17 SYSTem Subsystem

This subsystem comprises a series of commands for general functions.

COMMAND	PARAMETER	UNIT	COMMENT
SYSTem			
:COMMunicate			
:GPIB			
[:SELF]			
:ADDRess	0 to 30	–	
:RDEVice<1|2>			
:ADDRess	0 to 30	–	
:SERial<1|2>			
:CONTrol			
:DTR	IBFull | OFF		
:RTS	IBFull | OFF		
[:RECeive]			
:BAUD	<numeric_value>	–	
:BITS	7 | 8	–	
:PARity			
[:TYPE]	EVEN | ODD | NONE		
:SBITs	1 | 2	–	
:PACE	XON | NONE		
:DATE	<num>, <num>, <num>	–	
:ERRor?	–	–	query only
:PASSword			
[:CENable]	<string>		
:PRESet	–	–	
:SPEaker			
:VOLume	<numeric_value>	–	
:TIME	0 to 23, 0 to 59, 0 to 59	–	query only
:VERSion?	–	–	
			no query

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess

This command changes the IEC/IEEE-bus address of the unit.

Syntax: SYSTem:COMMunicate:GPIB[:SELF]:ADDRess 0 to 30

Example: `"SYST:COMM:GPIB:ADDR 18"`

Features: *RST value: - (no influence on this parameter)
SCPI: conforming

SYSTem:COMMunicate:GPIB:RDEVice<1|2>:ADDRess

This command changes the IEC/IEEE-bus address of the unit which is selected as hardcopy device 1 or 2, provided that the IEC/IEEE-bus interface of this unit is set as an interface.

Syntax: SYSTem:COMMunicate:GPIB:RDEVice<1|2>:ADDRess 0 to 30

Example: `"SYST:COMM:GPIB:RDEV2:ADDR 5"`

Features: *RST value: 4
SCPI: conforming

SYSTem:COMMunicate:SERial<1|2>:CONTrol:DTR
SYSTem:COMMunicate:SERial<1|2>:CONTrol:RTS

These commands switch the hardware handshake procedure for the given serial interface off (OFF) or on (IBFull).

Syntax: SYSTem:COMMunicate:SERial<1|2>:CONTrol:DTR IBFull | OFF
SYSTem:COMMunicate:SERial<1|2>:CONTrol:RTS IBFull | OFF

Examples: `"SYST:COMM:SER:CONT:DTR OFF"`
`"SYST:COMM:SER2:CONT:RTS IBF"`

Features: *RST value: OFF
SCPI: conforming

The two commands have the same meaning. SERial1 and SERial 2 correspond to device COM1and COM2, respectively.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD

This command sets the transmission speed for the given serial interface.

Syntax: SYSTem:COMMunicate:SERial<1|2>[:RECeive:]BAUD <numeric_value>
<numeric_value>::= 75 | 150 | 300 | 600 | 1200 | 2400 | 9600

Example: `"SYST:COMM:SER:BAUD 2400"`

Features: *RST value: 9600
SCPI: conforming

SERial1 and SERial 2 correspond to device interface COM1 and COM2, respectively. Permissible values are 75 Baud, 150 Baud, 300 Baud, 600 Baud, 1200 Baud, 2400 Baud, 4800 Baud, 9600 Baud.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITS

This command defines the number of data bits per data word for the given serial interface.

Syntax: SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITS 7 | 8

Example: `"SYST:COMM:SER2:BITS 7"`

Features: *RST value: 8
SCPI: conforming

SERial1 and SERial 2 correspond to device interface COM1 and COM2, respectively.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARity[:TYPE]

This command defines the parity check for the given serial interface.

Syntax: SYSTem:COMMunicate:SERial<1|2>:RECeive:PARity[:TYPE]
EVEN | ODD | NONE

Example: "SYST:COMM:SER:PAR EVEN"

Features: *RST value: NONE
SCPI: conforming

SERial1 and SERial 2 correspond to device interface COM1 and COM2, respectively. Permissible values are:

EVEN even Parity
ODD odd Parity
NONE no parity check.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:SBITs

This command defines the number of stopbits per data word for the given serial interface.

Syntax: SYSTem:COMMunicate:SERial<1|2>[:RECeive]:SBITs 1|2

Example: "SYST:COMM:SER:SBITs 2"

Features: *RST value: 1
SCPI: conforming

SERial1 and SERial 2 correspond to device interface COM1 and COM2, respectively.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PACE

This command switches on or off the software handshake für for the given serial interface.

Syntax: SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PACE XON | NONE

Example!: "SYST:COMM:SER:PACE XON"

features: *RST value: NONE
SCPI: conforming

SERial1 and SERial 2 correspond to device interface COM1 and COM2, respectively.

SYSTem:DATE

This command is used to enter the date for the internal calendar.

Syntax: SYSTem:DATE <num>,<num>,<num>
<num>,<num>,<num> ::= 1980 to 2099, 1 to 12, 1 to 31

Example: " SYST:DATE 1994,12,1"

Features: *RST value: –
SCPI: conforming

The sequence of entry is year, month, day.

SYSTem:ERRor?

This command queries the earliest entry to the error queue, thus deleting it.

Syntax: SYSTem:ERRor?

Example: "SYST:ERR?"

Features: *RST value: –
SCPI: conforming

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI (cf. Appendix B). If the error queue is empty, the error number 0, "no error", is returned. This command is identical with the command STATus:QUEue:NEXT?. This command is a query which is why it is not assigned an *RST value.

SYSTem:PASSword[:CENable]

This command enables access to the service functions by means of the password.

Syntax: SYSTem:PASSword[:CENable] <string>

Example: "SYST:PASS 'XXXX'"

Features: *RST value: –
SCPI: conforming

This command has no query

SYSTem:PRESet

This command triggers an instrument reset.

Syntax: SYSTem:PRESet

Example: "SYST:PRES"

Features: *RST value: –
SCPI: conforming

The effect of this command corresponds to that of the *PRESET* key with manual control or to the *RST command.

SYSTem:SPEaker:VOLume

This command sets the volume of the built-in loudspeaker for demodulated signals.

Syntax: SYSTem:SPEaker:VOLume <numeric_value>
<numeric_value> ::= 0 to 1

Example: "SYST:SPE:VOL 0.5"

Features: *RST value: 0
SCPI: device-specific

The value 0 is the lowest volume, the value 1 is the highest volume.

SYSTem:TIME

This command sets the internal clock.

Syntax: SYSTem:TIME 0 to 23, 0 to 59, 0 to 59

Example: `"SYST:TIME 12,30,30"`

Features: *RST value: –
SCPI: conforming

The sequence of entry is hour, minute, second.

SYSTem:VERSion?

This command queries the number of the SCPI version, which is relevant for the instrument.

Syntax: SYSTem:VERSion?

Example: `"SYST:VERS?"`

Features: *RST value: –
SCPI: conforming

This command is a query which is why it is not assigned an *RST value.

3.6.18 TRACe Subsystem

The TRACe subsystem controls access to the instrument's internal trace memory.

COMMAND	PARAMETER	UNIT	COMMENT
TRACe [:DATA]	TRACe1 | TRACe2 | TRACe3 | TRACe4, <block>|<numeric_value>...	-	

TRACe[:DATA]

This command transfers trace data from the controller to the instrument, the query reads trace data out of the instrument.

Syntax: TRACe[:DATA] TRACe1 | TRACe2 | TRACe3 | TRACe4,
<block>|<numeric_value>
TRACe[:DATA]? TRACe1 | TRACe2 | TRACe3 | TRACe4'

Example:
```
"TRAC TRACe1,"+A$    (A$: data list in the current format)
"TRAC? TRACe1"
```

Features: *RST value: -
SCPI: conforming

The trace data are transferred in the current format (corresponding to the command FORMat ASCiilREAL). The device-internal trace memory is addressed using the trace names 'TRACe1' to 'TRACe4'.
The parameter of the query is the trace name in the form of a string (TRACe1 to TRACe4), it indicates which trace memory will be read out.
The transfer of trace data from the controller to the instrument takes place by indicating the trace name and then the data to be transferred. In ASCII format, these data are values separated by commas. If the transfer takes place using the format real (REAL 32), the data are transferred in block format.

Saving and recalling trace data to/from the device-internal hard disk or to/from a floppy is controlled via the commands "MMEMory:STORe:TRACe" and "MMEMory:LOAD:TRACe" respectively.

3.6.19 TRIGger Subsystem

The TRIGger subsystem is used to synchronize instrument actions with events. This makes it possible to control and synchronize the start of a sweep.

COMMAND	PARAMETER	UNIT	COMMENT
TRIGger			
[:SEQuence]			
:SOURce	IMMediate|LINE|EXTernal|VIDeo	–	
:LEVel	<numeric_value>	V|MV|UV|PCT	
:HOLDoff	<numeric_value>	S	
:SLOPe	POSitive|NEGative	–	

TRIGger[:SEQuence]:SOURce

This command selects the trigger source for the start of a sweep.

Syntax: TRIGger[:SEQuence]:SOURce IMMediate | LINE | EXTernal | VIDeo

Example: `"TRIG:SOUR EXT"`

Features: *RST value: IMMediate
SCPI: conforming

The value IMMediate corresponds to the "FREE RUN" setting.

TRIGger[:SEQuence]:LEVel

This command sets the level of the trigger source.

Syntax: TRIGger[:SEQuence]:LEVel <numeric_value>
<numeric_value>::= 0 to 100% (TRIGger.SOURce VIDeo)
<numeric_value>::= –5.0 to +5.0V (TRIGger:SOURce EXTernal)

Example: `"TRIG:LEV 2V"`

Features: *RST value: 0% for TRIGger:SOURce VIDeo
–5.0V for TRIGger:SOURce EXTernal
SCPI: conforming

The set trigger level is only relevant when the trigger source is either VIDeo or EXTernal.

TRIGger[:SEQuence]:HOLDoff

This command defines the length of the trigger delay.

Syntax: TRIGger[:SEQuence]:HOLDoff <numeric_value>
<numeric_value>::= 0 to 100s

Example: `"TRIG:HOLD 500us"`

Features: *RST value: 0s
SCPI: conforming

TRIGger[:SEQuence]:SLOPe

This command selects the slope of the trigger signal.

Syntax: TRIGger[:SEQuence]:SLOPe POSitive | NEGative

Example: `"TRIG:SLOP NEG"`

Features: *RST value: POSitive
SCPI: conforming

The selected trigger slope applies to all trigger signal sources.

UNIT - Subsystem

The UNIT subsystem is used to switch the basic unit of setting parameters.

COMMAND	PARAMETER	UNIT	COMMENT
UNIT :POWer	DBM | DBPW | WATT | DBUV | VOLT | DBUA | AMPere		
:PROBe	<Boolean>		

&}

UNIT:POWer

This command selects the default unit for input and output.

Syntax: UNIT:POWer DBM | DBPW | WATT | DBUV | VOLT | DBUA | AMPere

Example: "UNIT:POW DBUV"

Features: *RST value: DBM
SCPI: conforming

UNIT:PROBe

This command determines whether the coding of a probe which is connected to the front panel is taken into consideration (ON) or not (OFF).

Syntax: UNIT:PROBe ON | OFF

Example: "UNIT:PROB OFF"

Features: *RST value: ON
SCPI: device specific

3.7 Instrument Model and Command Processing

The instrument model shown in Fig. 3.7-1 has been made viewed from the standpoint of the servicing of IEC-bus commands. The individual components work independently of each other and simultaneously. They communicate by means of so-called "messages".

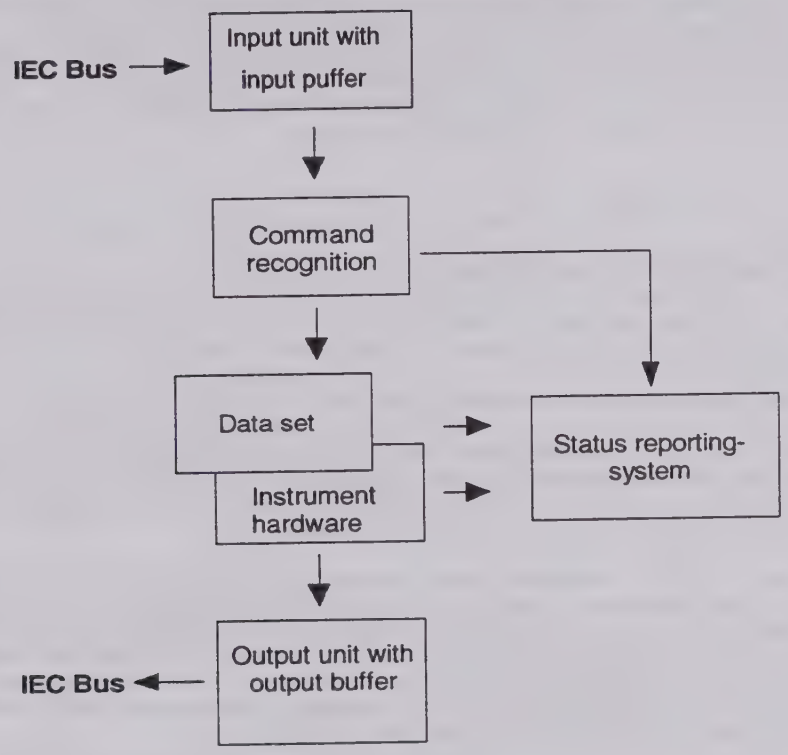


Fig. 3.7-1 Instrument model in the case of remote control by means of the IEC bus

3.7.1 Input Unit

The input unit receives commands character by character from the IEC bus and collects them in the input buffer. The input buffer has a size of 256 characters. The input unit sends a message to the command recognition as soon as the input buffer is full or as soon as it receives a delimiter, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.
If the input buffer is full, the IEC-bus traffic is stopped and the data received up to then are processed. Subsequently the IEC-bus traffic is continued. If, however, the buffer is not yet full when receiving the delimiter, the input unit can already receive the next command during command recognition and execution. The receipt of a DCL clears the input buffer and immediately initiates a message to the command recognition.

3.7.2 Command Recognition

The command recognition analyses the data received from the input unit. It proceeds in the order in which it receives the data. Only a DCL is serviced with priority, a GET (Group Execute Trigger), e.g., is only executed after the commands received before as well. Each recognized command is immediately transferred to the data set but without being executed there at once.
Syntactical errors in the command are recognized here and supplied to the status reporting system. The rest of a command line after a syntax error is analysed further if possible and serviced.
If the command recognition recognizes a delimiter or a DCL, it requests the data set to set the commands in the instrument hardware as well now. Subsequently it is immediately prepared to process commands again. This means for the command servicing that further commands can already be serviced while the hardware is still being set ("overlapping execution").

3.7.3 Data Set and Instrument Hardware

Here the expression "instrument hardware" denotes the part of the instrument fulfilling the actual instrument function - signal generation, measurement etc. The controller is not included.

The data set is a detailed reproduction of the instrument hardware in the software.

IEC-bus setting commands lead to an alteration in the data set. The data set management enters the new values (e.g. frequency) into the data set, however, only passes them on to the hardware when requested by the command recognition. As this is always only effected at the end of a command line, the order of the setting commands in the command line is not relevant.

The data are only checked for their compatibility among each other and with the instrument hardware immediately before they are transmitted to the instrument hardware. If the detection is made that an execution is not possible, an "execution error" is signalled to the status reporting system. All alterations of the data set are cancelled, the instrument hardware is not reset. Due to the delayed checking and hardware setting, however, it is permissible to set impermissible instrument states within one command line for a short period of time without this leading to an error message. At the end of the command line, however, a permissible instrument state must have been reached again.

Before passing on the data to the hardware, the settling bit in the STATus:OPERation register is set (cf. Section 3.8.3.4). The hardware executes the settings and resets the bit again as soon as the new state has settled. This fact can be used to synchronize command servicing.

IEC-bus queries induce the data set management to send the desired data to the output unit.

3.7.4 Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit on request. The exact structure and function are described in Section 3.8

3.7.5 Output Unit

The output unit collects the information requested by the controller, which it receives from the data set management. It processes it according to the SCPI rules and makes it available in the output buffer. The output buffer has a size of 4096 characters. If the information requested is longer, it is made available "in portions" without this being recognized by the controller.
If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data set management, the output unit sends error message "Query UNTERMINATED" to the status reporting system. No data are sent on the IEC bus, the controller waits until it has reached its time limit. This behaviour is specified by SCPI.

3.7.6 Command Sequence and Command Synchronization

What has been said above makes clear that all commands can potentially be carried out overlapping. Equally, setting commands within one command line are not absolutely serviced in the order in which they have been received.

In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line, that is to say, with a separate IBWRT()-call.
In order to prevent an overlapping execution of commands, one of commands *OPC, *OPC? or *WAI must be used. All three commands cause a certain action only to be carried out after the hardware has been set and has settled. By a suitable programming, the contoller can be forced to wait for the respective action to occur (cf. table 3.7-1).

Table 3.7-1 Synchronisation using *OPC *OPC? and *WAI

Commnd	Action after the hardware has settled	Programming the controller
*OPC	Setting the opteration-complete bit in the ESR	- Setting bit 0 in the ESE - Setting bit 5 in the SRE - Waiting for service request (SRQ)
*OPC?	Writing a "1" into the output buffer	Addressing the instrument as a talker
*WAI	Continuing the IEC-bus handshake	Sending the next command

An example as to command synchronization can be found in annex D "Program Examples".

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3.8 Status Reporting System

The status reporting system (cf. Fig. 3.8-2) stores all information on the present operating state of the instrument, e.g. that the instrument presently carries out an AUTORANGE and on errors which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via IEC bus.

The information is of a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated mask register standard event status enable (ESE) and registers STATus:OPERation and STATus:QUEStionable which are defined by SCPI and contain detailed information on the instrument.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills an analog function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in Fig. 3.8-2.

3.8.1 Structure of an SCPI Status Register

Each SCPI register consists of 5 parts which each have a width of 16 bits and have different functions (cf. Fig. 3.8-1). The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. For example, bit 3 of the STATus:OPERation register is assigned to the hardware status "wait for trigger" in all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integer.

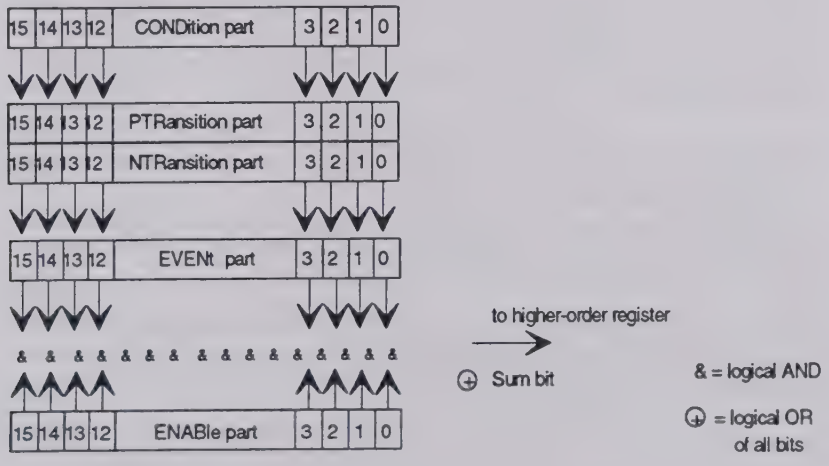
15 14 13 12 CONDition part 3 2 1 0
15 14 13 12 PTRansition part 3 2 1 0
15 14 13 12 NTRansition part 3 2 1 0
15 14 13 12 EVENt part 3 2 1 0
& & & & & & & & & & & & & &
15 14 13 12 ENABle part 3 2 1 0
to higher-order register
⊕ Sum bit
& = logical AND
⊕ = logical OR of all bits

Fig. 3.8-1 The status-register model

CONDition part

The CONDition part is directly written into by the hardware or the sum bit of the next lower register. Its contents reflects the current instrument status. This register part can only be read, but not written into or cleared. Its contents is not affected by reading.

PTRansition part

The Positive-TRansition part acts as an edge detector. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1.
PTR bit =1: the EVENt bit is set.
PTR bit =0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

NTRansition part

The Negative-TRansition part also acts as an edge detector. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
NTR-Bit = 1: the EVENt bit is set.
NTR-Bit = 0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

With these two edge register parts the user can define which state transition of the condition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.

EVENt part

The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the edge filters. It is permanently updated by the instrument. This part can only be read by the user. During reading, its contents is set to zero. In linguistic usage this part is often equated with the entire register.

ENABle part

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (cf. below). Each bit of the EVENt part is ANDed with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+').
ENABle-Bit = 0: the associated EVENt bit does not contribute to the sum bit
ENABle-Bit = 1: if the associated EVENT bit is "1", the sum bit is set to "1" as well.
This part can be written into and read by the user at will. Its contents is not affected by reading.

Sum bit

As indicated above, the sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.
The instrument automatically generates the sum bit for each register. Thus an event, e.g. a PLL that has not locked, can lead to a service request throughout all levels of the hierarchy.

Note: *The service request enable register SRE defined in IEEE 488.2 can be taken as ENABle part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be taken as the ENABle part of the ESR.*

3.8.2 Overview of the Status Registers

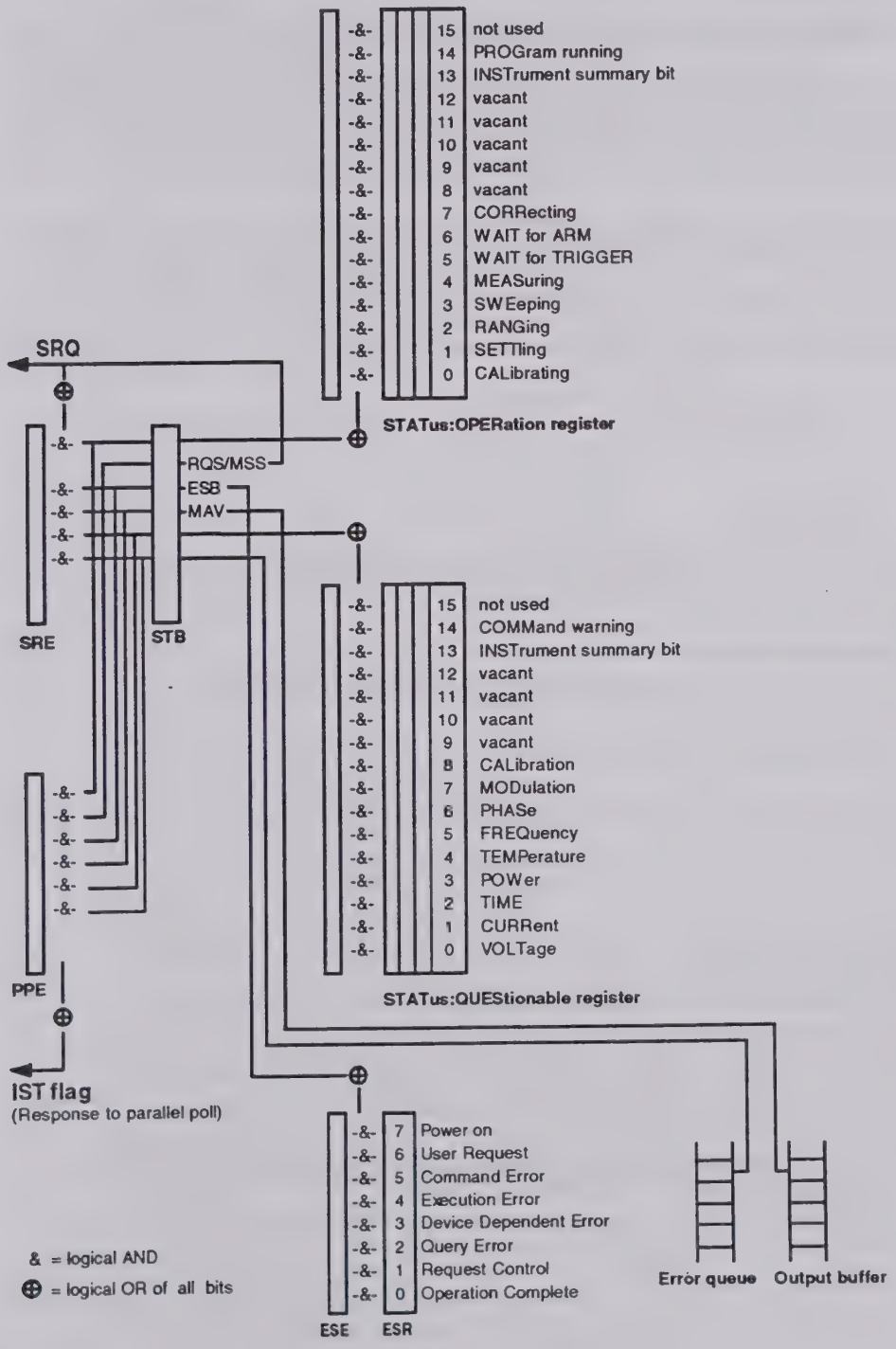

Fig. 3.8-2 Overview of the status registers

3.8.3 Description of the Status Registers

3.8.3.1 Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. It can thus be compared with the CONDition part of an SCPI register and assumes the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.
The STATUS BYTE is read out using the command "*STB?" or a serial poll.

The STB implies the SRE. It corresponds to the ENABle part of the SCPI registers as to its function. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) is generated on the IEC bus, which triggers an interrupt in the controller if this is appropriately configured and can be further processed there.
The SRE can be set using command "*SRE" and read using "*SRE?".

Table 3.8-1 Meaning of the bits used in the status byte

Bit No.	Meaning
2	**Error Queue not empty** The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a Service Request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with IEC-bus control.
3	**QUEStionable status sum bit** The bit is set if an EVENt bit is set in the QUEStionable-Status register and the associated ENABle bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by polling the QUEStionable-Status register.
4	**MAV bit** (message available) The bit is set if a message is available in the output buffer which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller (cf. annex D, program examples).
5	**ESB bit** Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit implies an error or an event which can be specified in greater detail by polling the event status register.
6	**MSS bit** (master status smmary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this registers is set together with its mask bit in the service request enable register SRE.
7	**OPERation status register sum bit** The bit is set if an EVENt bit is set in the OPERation-Status register and the associated ENABle bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be determined by polling the OPERation-status register.

3.8.3.2 IST Flag and Parallel Poll Enable Register (PPE)

By analogy with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (cf. Section 3.8.4.3) or using command "*IST?".

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, with bit 6 being used as well in contrast to the SRE. The Ist flag results from the ORing of all results. The PPE can be set using commands "*PRE" and read using command "*PRE?".

3.8.3.3 Event-Status Register (ESR) and Event-Status-Enable Register (ESE)

The ESR is already defined in IEEE 488.2. It can be compared with the EVENt part of an SCPI register. The event status register can be read out using command "*ESR?".
The ESE is the associated ENABle part. It can be set using command "*ESE" and read using command "*ESE?".

Table 3.8-2 Meaning of the bits used in the event status register

Bit No.	Meaning
0	**Operation Complete** This bit is set on receipt of the command *OPC exactly when all previous commands have been executed.
1	**Request Control** This bit is set if the instrument requests the controller function. This is the case when hardcopy is outputted to a printer or a plotter via the IEC-bus.
2	**Query Error** This bit is set if either the controller wants to read data from the instrument without having send a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
4	**Execution Error** This bit is set if a received command is syntactically correct, however, cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
5	**Command Error** This bit is set if a command which is undefined or syntactically incorrect is received. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the rror queue (cf. annex B, -Error Messages).
6	**User Request** This bit is set on pressing the *LOCAL* key, i. e., when the instrument is switched over to manual control.
7	**Power On** (supply voltage on) This bit is set on switching on the instrument.

3.8.3.4 STATus:OPERation Register

In the CONDition part, this register contains information on which actions the instrument is being executing or, in the EVENt part, information on which actions the instrument has executed since the last reading. It can be read using commands `"STATus:OPERation:CONDition?"` or `"STATus:OPERation[:EVENt]?"`.

Table 3.8-3 Meaning of the bits used in the STATus.OPERation register

Bit No.	Meaning
0	**CALibrating** This bit is set as long as the instrument is performing a calibration.
1	**SETTling** This bit is set as long as the new status is settling after a setting command. It is only set if the settling time is longer than the command processing time.
2	**RANGing** This bit is set as long as the instrument is changing a range (e.g. Autorange).
3	**SWEeping** This bit is set while the instrument is performing a sweep.
4	**MEASuring** This bit is set while the instrument is performing a measurement.
5	**WAIT for TRIGGER** This bit is set as long as the instrument is waiting for a trigger event.
6	**WAIT for ARM** This bit is set as long as the instrument is waiting for an arming event.
7	**CORRecting** This bit is set while the instrument is performing a correction.
8 - 12	Device dependent
13	**INSTrument Summary Bit** This bit is set when one or more logical instruments is reporting a status message.
14	**PROGram running** This bit is set while the instrument is performing a program.
15	This bit is always 0

The spectrum analyzer supports bits 0 and 5.

3.8.3.5 STATus:QUEStionable-Register

This register contains information on questionable instrument states. They can occur, e.g. if the instrument is operated out of its specifications. It can be read using commands `STATus:QUEStionable:CONDition?` or `STATus:QUEStionable[:EVENt]?`

Table 3.8-4 Meaning of the bits used in the STATus:QUEStionable register

Bit No.	Meaning
0	**VOLTage** This bit is set if a questionable voltage occurs.
1	**CURRent** This bit is set if a questionable current occurs.
2	**TIME** This bit is set if a questionable time occurs.
3	**POWer** This bit is set if a questionable power occurs.
4	**TEMPerature** This bit is set if a questionable temperature occurs.
5	**FREQuency** The bit is set if a frequency is questionable.
6	**PHASe** The bit is set if a phase value is questionable.
7	**MODulation** The bit is set if a modulation is performed questionably.
8	**CALibration** The bit is set if a calibration is not performed properly.
9-12	Device dependent
13	**INSTrument Summary Bit** This bit is set when one or more logical instruments is reporting a message.
14	**COMMand Warning** This bit is set if the instrument ignores parameters when executing a command.
15	This bit is always 0.

The spectrum analyzer supports bits 0 and 5, bit 7 (MODulation) is supported only with the option "signal vector analysis".

3.8.4 Application of the Status Reporting Systems

In order to be able to effectively use the status reporting system, the information contained there must be transmitted to the controller and further processed there. There are several methods which are represented in the following. Detailed program examples are to be found in annex D, Program Examples.

3.8.4.1 Service Request, Making Use of the Hierarchy Structure

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react with corresponding actions. As evident from Fig. 3.8-2 (Section 3.8.2), an SRQ is always initiated if one or several of bits 2, 3, 4, 5 or 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of a further register, the error queue or the output buffer. The corresponding setting of the ENABle parts of the status registers can achieve that arbitrary bits in an arbitrary status register initiate an SRQ. In order to make use of the possibilities of the service request, all bits should be set to "1" in enable registers SRE and ESE.

Examples (cf. Fig. 3.8-2 and annex D, Program Examples, as well):

Use of command "*OPC" to generate an SRQ at the end of a sweep.

- Set bit 0 in the ESE (Operation Complete)
- Set bit 5 in the SRE (ESB)?

  After its settings have been completed, the instrument generates an SRQ.

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request. A detailed example for a service request routine is to be found in annex D, Program Examples.

3.8.4.2 Serial Poll

In a serial poll, just as with command "*STB", the status byte of an instrument is queried. However, the query is realized via interface messages and is thus clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works with instruments which do not adhere to SCPI or IEEE 488.2.

The quick-BASIC command for executing a serial poll is "IBRSP()". Serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the IEC bus.

3.8.4.3 Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 bit of information each on the data lines, i.e., to set the data line allocated to each instrument to logically "0" or "1". By analogy to the SRE register which determines under which conditions an SRQ is generated, there is a parallel poll enable register (PPE) which is ANDed with the STB bit by bit as well considering bit 6. The results are ORed, the result is then sent (possibly inverted) as a response in the parallel poll of the controller. The result can also be queried without parallel poll by means of command "*IST".

The instrument first has to be set for the parallel poll using quick-BASIC command "IBPPC()". This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using "IBRPP()".

The parallel-poll method is mainly used in order to quickly find out after an SRQ which instrument has sent the service request if there are many instruments connected to the IEC bus. To this effect, SRE and PPE must be set to the same value. A detailed example as to the parallel poll is to be found in annex D, Program Examples.

3.8.4.4 Query by Means of Commands

Each part of every status register can be read by means of queries. The individual commands are indicated in the detailed description of the registers in Section 3.8.3. What is returned is always a number which represents the bit pattern of the register queried. Evaluating this number is effected by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

3.8.4.5 Error-Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain-text error messages which can be looked at in the ERROR menu via manual control or queried via the IEC bus using command "SYSTem:ERRor?". Each call of "SYSTem:ERRor?" provides an entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

3.8.5 Resetting Values of the Status Reporting System

Table 3.8-5 comprises the different commands and events causing the status reporting system to be reset. None of the commands, except for *RST and SYSTem:PRESet influences the functional instrument settings. In particular, DCL does not change the instrument settings.

Table 3.8-5 Resettting instrument functions

Event / Effect	Switching on supply voltage: Power-On-Status-Clear 0	Switching on supply voltage: Power-On-Status-Clear 1	DCL,SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
Clear STB,ESR	—	yes	—	—	—	yes
Clear SRE,ESE	—	yes	—	—	—	—
Clear PPE	—	yes	—	—	—	—
Clear EVENTt parts of the registers	—	yes	—	—	—	yes
Clear Enable parts of all OPERation and QUEStionable registers, Fill Enable parts of all other registers with "1".	—	yes	—	—	yes	—
Fill PTRansition parts with "1", Clear NTRansition parts	—	yes	—	—	yes	—
Clear error queue	yes	yes	—	—	—	yes
Clear output buffer	yes	yes	yes	1)	1)	1)
Clear command processing and input buffer	yes	yes	yes	—	—	—

1) Every command being the first in a command line, i.e., immediately following a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.

4 Maintenance and Troubleshooting

4.1 Maintenance

4.1.1 Mechanical Maintenance

The FSE does not require any mechanical maintenance. The front panel can be cleaned from time to time using a damp, soft cloth.

4.1.2 Electrical Maintenance

4.1.2.1 Testing the Level Measuring Accuracy

Due to the total calibration facility by means of the built-in calibration generator, high long-term stability of the level measuring characteristics is guaranteed. It is recommended to check the measuring accuracy every two years according to section 5. Reprogramming of the correction data by a R&S servicing shop is necessary, if tolerances are exceeded.

4.1.2.2 Testing the Frequency Accuracy

The frequency accuracy of the reference oscillator is to be checked twice a year according to section 5. It is not necessary to perform this test if the instrument is operated using an external reference.

Test utility: Frequency counter of signal generator

Test setup: Measurement with frequency counter
Connect frequency counter to the REF OUT/IN socket at the rear of the instrument.

Measurement with signal generator
Apply signal with 1GHz, -10dBm to RFin.

Measurement: Settings on FSE:

CENTER	1000 MHz
SPAN	0 MHz
REF LEVEL	-10 dBm
COUNTER RESOL	0.1 Hz

Activate internal frequency counter (marker function)

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4.2 Monitoring the Function of the FSE

4.2.1 Switch-on Test

Following switch-on of the instrument a selftest of the processor functions is executed first. Subsequently, the transputer net is initialized, which adopts control of the analog modules.

4.2.2 Monitoring of the Synthesizers and Signal Levels

The FSE is provided with a large amount of selftest points which can be switched to an A/D converter via multiplexer. Most of these test points are located on the analog modules and, by means of level detectors, allow for monitoring the levels in the signal path, the output levels of the LO drivers and the tuning voltages of the oscillators. The selftest voltages which are required for proper functioning, are additionally monitored by comparators. The output signals of these comparators are stored and checked by the level transputer during each request of a measured value. If one of these comparators responds, one of the following error messages is output:

Message	Meaning	see Section
Referenz unlock	Reference oscillator not synchronized	"Error Messages of the Synthesizer"
1st LO unlock	First LO not synchronized	"Error Messages of the Synthesizer"
2nd/3rd LO unlock	Second and third LO not synchronized	"Error Messages of the Synthesizer"
Level 1st LO	LO level at first mixer too small	"Error Messages of the Synthesizer"
Level 2nd LO	LO level at second mixer too small	"Error Messages of the Synthesizer"
Level 3rd LO	LO level at third mixer too small	"Error Messages of the Synthesizer"
RF OVR	Input signal too large	"Overload Messages"
IF OVR	Signal following IF amplifier too large	"Overload Messages"

4.2.3 Error Messages of the Synthesizer

When the message LO unlock is displayed, the instrument continues operating, however, the signals indicated may have been shifted on the frequency axis. In particular, when the instrument is operated at about the maximum or minimum operating temperature, it may occur, after ageing of the analyzer, that the tuning voltage of the voltage-controlled oscillators drift at the limit of the permitted range. Therefore, correction of the pretuning is provided for the first LO (YIG oscillator) and the third LO (VCO) which is performed during total calibration of the instrument, thus eliminating the error. Correction is not required for the second LO, since it is obtained by multiplication of the third LO. For measuring accuracy reason, it is recommended with very cold or hot environment to call the total calibration of the instrument (after a warm-up period of at least 30 minutes).

When the message "Referenz unlock" is output and if the analyzer is set to external reference, check that the latter is applied with the correct frequency and sufficient level. If the analyzer is set to internal reference, the message should only occur during a short warm-up phase following switch-on.
The message Level Lo means that the level at the LO gate of one of the mixers is too low, which may lead to dips in the conversion attenuation. In any case, this message indicates a fault inside the instrument.

4.2.4 Overload Messages

The messages RF-OVR and IF-OVR indicate an overload in the signal path of the instrument. These messages are a warning that the analyzer indication will seem to be wrong, because one stage in the signal path is operated with the 1-dB compression or above.
The message RF-OVR indicates that one stage preceding the variable IF amplifier is operated with an exceeded level. The level can only be reduced by an increased attenuation of the input attenuator (RF Attenuation). Overload at the input mixer and in the subsequent stages frequently occurs, if pulsed or highly modulated signals are applied. Such signals have a high peak value compared to the input bandwidth and this may lead to compression of these stages.
If this message is output without an input signal being applied, the input mixer is defective. The LO feedthrough (= the level display with input frequency zero) depends to a large extent on the balance of the input mixer. Since a partially faulty mixer becomes very unbalanced, thus providing very high LO feedthrough, this may lead to overload of the subsequent stages and thus to output of the message RF-OVR.
The message IF-OVR indicates compression in one stage following the switchable IF amplifier. This can be remedied even with fixed input attenuation by increasing the reference level. In analyzer mode, the IF amplification depends on the reference level and the RF attenuation: IF ampl./dB = -10 + RF-Att/dB. - Ref.-Lev./dBm.

4.3 Function Description of the Overall Instrument

4.3.1 Introduction

This section informs on the theory of operation of this instrument.

4.3.2 Modules of the Analog Unit

All modules of the analog unit contain an individually programmed EEPROM indicating the model and correction data, such as frequency response, filter parameters, insertion gain. The analog unit consists of the following modules:

- RF modules with RF converter and YIG sampler forming part of the RF module
- 2nd IF converter
- IF filter
- Fracsyn with static transputer module
- Detector board with dynamic transputer module and DSP module
- Analog motherboard

4.3.3 Modules of the Digital Unit

The boards of the digital unit do not contain any particular correction data. The digital unit is independent of the type of instrument, the only difference is the amount and type of plug-in boards fitted such as VGA board for the DOS option or a network board. The digital unit consists of the following modules:

- Main processor
- Graphic board
- Digital motherboard (containing the interface drivers such as IEC bus, LPT and COM)
- Hard disk
- Floppy disk
- LC display
- Keypad

4.3.4 Description of the Analog Unit

The FSE has been conceived as analyzer with triple conversion. Special importance has been attached to reaching high display dynamics, i.e., the individual amplifier stages have not only been trimmed to minimum displayed noise level but adjusted such that they provide good intermodulation characteristics with an acceptable noise factor.

The input signal passes a switchable input divider (attenuation range 0 to 70dB in steps of 10dB), which also switches the internal calibration and test signal.
In the RF converter, the signal is converted to the 1st IF of 4.3414 GHz (FSEB: 7.9414 GHz) using the 1st LO (FSEA: 4.3414 to 7.8414 GHz, FSEB: 7.9414 to 14.9414 GHz) after having passed the input lowpass in the 1st mixer. Following the 1st IF filter and the IF gain, the signal is converted to the 2nd IF of 741.4MHz.
By those FSE models having a frequency range greater than 7 GHz, the signal is divided, after the input divider, in a switchable diplexer. The portions of the signal below 7 GHz are further processed in the RF converter. The portions of the signal above 7 GHz are fed via a YIG filter to the MW converter. The conversion of the IF of 741.4 MHz takes place in this module. The LO required for the conversion comes from the RF converter and, depending on the frequency range, is either fed directly or via a doubler to the mixer.
The next module in the signal path is the 2nd IF Converter, which provides for conversion of the second IF to the third IF of 21.4 MHz and generation of the second and third LO. Apart from several amplifiers it contains a filter on 741.4 MHz with a 3-dB bandwidth of 10 MHz. This filter serves as resolution filter if the resolution bandwidth is 10 MHz and it reflects the image frequency which might be generated by the third conversion.

The resolution filters for bandwidths between 1 kHz and 5 MHz are located on the IF filter board. With the 10-MHz bandwidth, the filter stages of the board are bypassed. Crystal filters are used for bandwidths between 1 and 30 kHz, LC filters are provided for bandwidths of 50 kHz or above. The individual filter stages have been decoupled from each other by means of amplifiers which is why they act as Gaussian filter. Subsequent to the first two filter stages, switchable IF amplifiers (Step Gain) and two independent calibration amplifiers are fitted. The step gain can be switched in 0.1-dB steps from 0 to 50 dB and is used to amplify the signal on the reference level. One of the two calibration amplifiers is used to compensate for the deviations of amplification with different bandwidth or step-gain settings. This amplifier is controlled via the serial interface of the level transputer and a D/A converter on the IF filter board. The second calibration amplifier is controlled by an analog voltage, which is modified by the frequency transputer during the sweep according to the frequency response of the input stages. The IF filters are followed by the log module, which provides for a dynamic of 90 or 110 dB depending on the model. The video signal thus created is passed to the detector board. There, it is through-connected to the rear panel.

If resolution bandwidths are < 1kHz, the signal path via the log module remains unused. The signal is still filtered by the IF filter board to a bandwidth of 3 kHz, but then converted to a 25-kHz IF and filtered digitally on the module. An 18-bit A/D converter is provided on the digital IF for sampling with the 25-kHz IF.

A measuring A/D converter with a sampling rate of 20 MHz is provided on the detector board. Due to the high sampling rate of the A/D converter the analog peak detectors are not required, they are digitally simulated following the converter. Video filtering is carried out digitally, too, in the noise filter gate-array on the detector board. For video bandwidths <= 20 kHz, additional filtering is carried out using a DSP, which remains disabled above 20 kHz.

4.3.5 Processor Structure

Apart from a 80486 CPU, the FSEA is provided with three T805-32-bit transputers and a 16-bit transputer T225. Two DSPs are provided in the basic instrument for digital signal processing.

The 80486 CPU controls the complete data exchange with the periphery, such as keybaord entry, representation of the softkeys and operation via the IEC bus. The transputers independently control the test procedure, calculate correction factors and display the measuring curve on the screen. The transputers are provided with the current instrument settings by the 80486 CPU via a link adapter, which connects the ISA bus of the CPU board with a transputer link of the T805 on the graphic board (called GTP = graphic transputer in the following). Other transputer links couple the T224 on the graphics board and the two T805 on the detector board (LTP = level transputer) and the Fracsyn (FTP = frequency transputer) to the GTP. T225 is exclusively used as interface between the GTP and the chipset for graphics.

4.3.5.1 Tasks of the Level Transputer

The PTP receives the level-dependent settings from the graphic transputer and causes the corresponding switchovers in the hardware to be made via a serial interface. The PTP has the following functions: making the level-dependent settings such as attenuation of the attenuator, the bandwidths on the IF filter and level correction with the calibration frequency (120 MHz) and, on the other hand, programming of the DSPs, obtaining the measured values and passing the measured values to the graphic transputer via the transputer link. To meet these requirements, the PTP is provided with its individual serial bus to those boards which require level-dependent settings. I.e., the modules IF filter, digital IF, attenuator control board.

4.3.5.2 Tasks of the Frequency Transputer

The FTP receives the current sweep setting from the graphic transputer via the PTP and calculates the required synthesizer settings. For settings which have to be made during a sweep, the FTP is fitted with a fast parallel bus on the fracsyn module, which also addresses the sweep synthesizer. The subsequent settings have to be made: the frequency-dependent level correction, coarse tuning of the YIG oscillator and control of the sweep output. The fracsyn module therefore accommodates D/A converters which are programmed parallely during the sweep and which provide control voltages. The voltage for the sweep output is applied to the rear panel where it provides a sawtooth voltage which starts at 0V at the sweep start and increases to 10 V at the end of sweep. The voltage for frequency-response correction is passed to a voltage-controlled amplifier on the IF filter board which compensates for the frequency-dependent attenuation characteristic of the input stages. The third tuning voltage leads to the RF module where the main coil of the YIG oscillator which is integrated in the YIG sampler is controlled by means of a voltage-controlled current source, thus controlling the coarse tuning of the first LO. D/A converters which are required for options are provided in the basic FSE model. A serial bus is available for the FTP to use when controlling time-critical settings.

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4.4 Selftest

The selftest allows for checking the instrument functions without using additional test instruments. When an instrument error occurs, the module which caused the error is indicated on the screen. The following measures are taken to localize an error:

- An additional A/D converter is provided which allows for measuring voltages on the various modules.
- While the selftest is being performed, important dc voltages, on-board supply voltages and amplifier operating points are measured and compared to their rated values.
- Level detectors check the oscillator levels required for operating the mixers
- The calibration generator generates a 120-MHz signal with a level of 0 dBm at the RF input of the instrument. The on-board level detectors in the signal path allow for processing of the input signal in the individual RF and IF stages.

4.4.1 Operation

Operation of the selftest is explained in Chapter 2, Section "Selftest Functions".

4.4.2 Testing the Processor Functions

The test of the processor functions comprises testing of the interface chips and the dynamic RAM, test of the graphic board and the connected transputers.
If the CPU, the dynamic RAM or the hard disk are defective, the instrument may not be able any more to output a detailed error message.

4.4.3 Testing the Synthesizers

Correct functioning of all oscillators is absolutely necessary for checking the signal path. Therefore, all synthesizer modules are checked next. The synthesizer modules are tested in the following order:

1. Test of the reference frequencies with 10 MHz and 120 MHz and the derived signals with 20, 30 and 60 MHz.
2. Measurement of the signals applied to the YIG sampler (output signal of fracsyn and output signal of sampler)
3. Test of the YIG main loop with the cutoff frequencies by measuring the YIG tuning voltage
4. Check of the LO levels and of the operating points of the LO drivers

In case of an error the selftest is aborted since it does not make sense measuring the signal path if e.g., no LO level is provided.

4.4.4 Testing the Signal Path

Subsequently, the modules in the signal path are checked. The fracsyn module accommodates a 120-MHz calibration generator, the output power of which is checked using individual test points. This signal is connected into the signal path via a changeover switch in the input attenuator of the FSE. The test sequence is as follows:

1. Check of the RF attenuator
2. Check of the RF converter by testing the operating points of the amplifiers
3. Check of the 2nd IF converter by testing the operating point of the amplifier for the second IF and reading out of the level detectors in the signal path.
4. Check of the IF filters by testing the supply voltages for the individual filter circuits, the tuning voltages for the filter bandwidths and the level detectors.
5. Check of detector board

Though the selftest provides high measuring depth, it cannot be assumed that the module which has been found out to be faulty is always really faulty. A faulty cable, e.g., has the same effect as an interrupt in the input attenuator. Therefore, have the faulty function checked by an R&S servicing shop when an error message occurs.

5 Checking the Rated Specifications

5.1 Measuring Equipment and Accessories

Item	Type of equipment	Specifications required	Recommended equipment	R&S Order No.	Use
1	Frequency counter	Errorr < $1x10^{-9}$, frequency range up to 1GHz			5.2.2
2	Signal generator	10 MHz to 26.5 GHz phase noise at 498 MHz: < -90 dBc/Hz at @ 100 Hz < -110 dBc/Hz at @ 1 kHz < -123 dBc/Hz at @ 10 kHz < -123 dBc/Hz at @ 100 kHz < - 140 dBc/Hz at @ 1MHz	SMHU and SMP03	0835.8011.52 1035.5005.03	5.2.1. 5.2.3 to 5.2.11
3	Signal generator	10 MHz to 26.5 GHz	SMP03 with option SMP-B11	1035.5005.03 1036.6240.02	5.2.3 to .5.2.8
4	3-dB coupler (power combiner)	10 MHz to 3.5 GHz (FSEA), 10 MHz to 7 GHz (FSEB), 10 MHz to 26.5 GHz (FSEM), decoupling > 20 dB			5.2.5
5	6-dB divider (power splitter)	10 MHz to 3.5 GHz (FSEA), 10 MHz to 7 GHz (FSEB), 10 MHz to 26.5 GHz (FSEM)			5.2.8
6	50-Ω termination	Return loss > 20 dB	RNA	0272.4510.50	5.2.7
7	Two-channel power meter	100 kHz to 26.5 GHz, error < 0.1 dB	NRVD with probe NRV-Z7 (FSEA/B) NRV-Z6 (FSEM)	0857.8008.02 0828.5210.22 0828.5010.02	5.2.1 5.2.3 5.2.8
8	Reflection coefficient VSWR bridge (FSEA/FSEB)		ZRMD	0831.7010.53	5.2.3
9	Scalar network analyzer (FSEM)	2 GHz to 26.5 GHz			5.2.3
10	Attenuator		RSP	0831.3515.02	5.2.9 to 5.2.11
11	Lowpass	Switchable			5.2.5

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5.2 Test Instructions

The rated specifications of the analyzer are tested after a run-in time of at least 30 minutes and overall calibration. Only in this way can the compliance of the guaranteed data be ensured.

Values given in the following sections are not guaranteed. Only the technical specifications of the data sheet are binding.

5.2.1 Checking the Calibration Source at 120 MHz

Test equipment

- Signal generator (section 5.1, item 2)
- Power meter (section 5.1, item 7)

Test setup

Connect signal generator to RF input of the FSE

Measurement

➢ Signal generator settings.
- Frequency 120 MHz
- Level -40 dBm ± 0.1 dB
(measurement with power meter)

➢ FSE settings
- CENTER 120 MHz
- SPAN 15 kHz
- RBW 5 kHz
- REF LVL -10 dBm
- RF ATT 20 dB

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*],

➢ Read off marker level

➢ Switch internal reference generator to RF input
[***SERVICE***: *INPUT CAL*]

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off marker level

Difference between the two levels .....< 0.3 dB

Note: *With R22 on FracSyn module, the reference level can be adjusted to the same level display of the marker as with signal applied from the signal generator.*

5.2.2 Checking the Frequency Accuracy of the Reference Oscillator

Test equipment — Frequency counter (section 5.1, item 1)

Test setup — Connect frequency counter to 10-MHz reference output of the FSE

Measurement

➢ Measure frequency with frequency counter

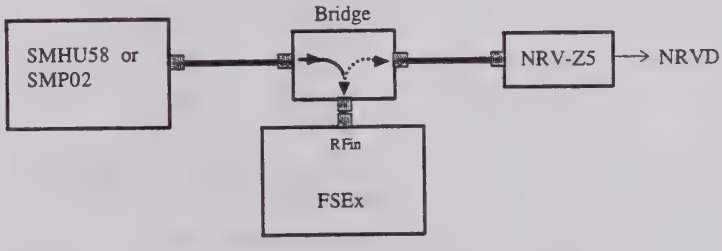
Nominal frequency
Model 20 without OCXO (option B4) ..... 10 MHz ±10 Hz
Model 30 or 20 with OCXO (option B4) ..... 10 MHz ±1 Hz

5.2.3 Checking the Return Loss at the RF Input

Test equipment

- Signal generator (section 5.1, FSEA: item 2; FSEB/FSEM: item 3)
- Power meter (section 5.1, item 7)
- Reflection coefficient bridge (section 5.1, item 8)(FSEA/FSEB)
- Network analyzer (section 5.1, item 9)(FSEM)

Test setup



Difference to FSEM: connect network analyzer to FSEM

Calibration

Use the total reflection (OPEN or SHORT) at the bridge as reference.

➢ Open cable to FSE and store power meter value as reference (for all test frequencies)

Measurement

➢ Measure reflected power at the bridge with the FSE at the frequencies indicated in the table.

Return loss = $power_{(with\ FSE)} - power_{(w/o\ FSE)}$

	Nominal value of return loss			
RF attenuation	100 Hz to 1 GHz	FSEA 1 GHz to 3.5 GHz	only FSEB 3.5 GHz to 7 GHz	only FSEM 7 GHz to 26.5 GHz
0 dB	6 dB	6 dB	5 dB	-
10 dB	14 dB	14 dB	9.5 dB	6 dB

Notes:

- *The measurement at f < 7GHz should be performed at least every 250 MHz, at f > 7 GHz every 1 GHz*
- *5-dB return loss corresponds to a VSWR of 3.5*
  6-dB return loss corresponds to a VSWR of 3
  9.5-dB return loss corresponds to a VSWR of 2
  14-dB return loss corresponds to a VSWR of 1.5

5.2.4 Checking Image Frequency Rejection

Test equipment: Signal generator (section 5.1, item 3)

Test setup: Connect signal generator to the RF input of the FSE.

Preliminaries:

- Signal generator setting.
  - Level -10 dBm
- FSE setting
  - RF ATT 0 dB
  - RBW 1 kHz
  - SPAN 3 kHz
  - REF LVL -20 dBm

5.2.4.1 1st IF Image Frequency

Measurement FSEA:

- Signal generator setting
  - Frequency f_{in} + 8682.8 MHz
- FSEA setting
  - Frequency f_{in} 11, 100, 1701 and 3499 MHz

FSEB/FSEM:

- Signal generator setting
  - Frequency f_{in} +15.8828 GHz
- FSEB and FSEM setting
  - Frequency f_{in} 11, 100, 1701, 3499 MHz and 6999 MHz

Evaluation:

- Measure level P_{dis} at frequency f_{in}.

The image frequency rejection in dB is obtained with:
-10dBm – P_{dis}

Image frequency rejection ..... > 80dB

5.2.4.2 2nd IF Image Frequency

Measurement

➢ Signal generator setting
- Frequency f_{in} + 1582.8 MHz (f_{in} + 2 x 2. IF)

FSEA/FSEB

➢ FSEA/FSEB setting
- Frequency f_{in}: 999 MHz

FSEM

➢ FSEM setting
- Frequency f_{in}: 999 MHz and 7999 MHz

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off marker level (= P_{dis})

Evaluation

The image frequency rejection in dB is obtained with:
-10dBm – P_{dis}

Image frequency rejection ..... > -80dB

5.2.4.3 IF Rejection

Measurement FSEA

➢ Signal generator setting
Frequency 4341.4 MHz

FSEB/FSEM

➢ Signal generator setting
Frequency 7941.4 MHz

➢ FSE setting
Frequency f_{in}: 100, 1701 and 3500 MHz

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off marker level (= P_{dis})

Evaluation

The IF rejection is obtained with: -10dBm – P_{dis}

IF rejection
FSEA30.....> 100 dB
FSEA20.....> 80 dB
FSEB and FSEM.....> 75 dB

5.2.5 Checking Non-linearities

5.2.5.1 Third-Order Intercept

Test equipment

- 2 signal generators (section 5.1, item 2 and item 3)
- 3-dB combiner (section 5.1, item 4)

Test setup

Connect the two signal generators to the RF input of the FSE via the 3-dB combiner.

Measurement

➢ Signal generator setting
- Level on FSE -10 dBm at f_{S1} and f_{S2}
- Frequencies f_{S1} and f_{S2} see table

f_{S1}	f_{S2}
10.2 MHz	10.21 MHz
28 MHz	28.01 MHz
106 MHz	106.01 MHz
261 MHz	261.01 MHz
640 MHz	640.01 MHz
1 GHz	1.00001 GHz
1.7 GHz	1.70001 GHz
2.5 GHz	2.50001 GHz
3.48 GHz	3.48001 GHz
6.98 GHz (FSEB/FSEM)	6.98001 GHz
7.5 GHz (FSEB/FSEM)	7.50001 GHz
15 GHz (FSEM)	15.00001 GHz
25 GHz (FSEM)	25.00001 GHz

➢ FSE setting
- RF ATT 0 dB
- RBW 3 kHz
- REF LVL -10 dBm
- SPAN 3 kHz

➢ Set center frequency to f_{S1} - 10 kHz on the FSE
[FREQUENCY CENTER] = f_{S1} - 10 kHz ;

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off and note marker level (P_{-ip}).

➢ Set center frequency to f_{S2} + 10 kHz on the FSE
[FREQUENCY CENTER] = f_{S2} + 10 kHz

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off and note marker level (P_{+ip}).

Evaluation

➢ Form average value (P_{icp}) of P_{-ip} and P_{+ip}.

➢ Calculate intercept IP3 according to the following formula:
IP3/dBm = (P_{icp} / 2)-10 dBm

Intercept IP3
FSEA
f_S < 50 MHz ..... > 7 dBm
f_S ≥ 50 MHz.....>12 dBm
FSEB/FSEM
f_S < 150 MHz..... > 7 dBm
f_S ≥ 150 MHz.....>12 dBm

5.2.5.2 Second-Order Intercept

Test equipment

- Signal generator (section 5.1, item 3)
- Switchable lowpass (section 5.1, item 11)

Test setup

Connect signal generator to the RF input of the FSE via the lowpass suitable for receive frequency.

Note: *if the harmonic suppression of the signal generator is sufficient, the lowpass can be left out.*

Measurement

➢ Signal generator setting
- Level on FSE -10 dBm at f_{S1}
- Frequencies f_{S1}:
9 kHz, 35 kHz, 99 kHz, 19 MHz, 28 MHz, 107 MHz, 262 MHz, 453 MHz, 640 MHz, 1 GHz, 1.25 GHz and 1.7 GHz

➢ FSE setting
- RF ATT 0 dB
- RBW 1 kHz
- REF LVL -10 dBm
- SPAN 3 kHz

➢ Set center frequency to $f_{S1} \times n$ on FSE
[***FREQUENCY CENTER***] = $f_{S1} \times n$
(n = 2 to 6 or max. 3500 MHz (FSEA)
7000 MHz (FSEB/FSEM)

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off marker level (P_{K2})

Evaluation

➢ Calculate intercept IP2 according to the following formula (using the highest value of P_{K2})
IP2/dBm = (-10 dBm - P_{K2}) - 10 dBm

Intercept IP2

FSEA	f_S < 50 MHz	> 25 dBm
	$f_S \geq$ 50 MHz	> 45 dBm
FSEB /FSEM	f_S < 150 MHz	> 25 dBm
	$f_S \geq$ 150 MHz	> 40 dBm

5.2.6 Checking IF Bandwidths

Test equipment

Signal generator (section 5.1, item 2)

Test setup

Connect signal generator to the RF input of the FSE.

Measurement

➢ Signal generator setting.
- Frequency 120 MHz
- Level -20dBm

➢ FSE setting
- CENTER 120 MHz
- RF ATT 30 dB
- REF LVL 0 dBm
- VBW = RBW
- Span = RBW x 30
- RBW 100Hz, 1kHz to 10 MHz

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*];

➢ Read off marker level.

➢ Determine 3-dB bandwidth.
[***MARKER SEARCH***: *PEAK*: *N DB DOWN*: 3 dB];
Read off the frequency spacing of markers.
The frequency spacing is the 3-dB bandwidth ($B_{3\,dB}$).

➢ Determine shape factor.
[***MARKER SEARCH***: *SHAPE FACT 60 dB/3 dB)*]

➢ Check:

Bandwidth (RBW)	Level deviation	3-dB bandwidth	Shape factor (model 20)	Shape factor (model 30)
5 kHz	= Reference (Ref)	5 kHz ± 10%	< 15	< 12
100 Hz	Ref ± 0.2 dB	100 Hz ± 10%	< 6	< 6
1 kHz to 30 kHz	Ref ± 0.2 dB	BW ± 10%	< 15	< 12
50 kHz	Ref ± 0.6 dB	BW ± 10%	< 15	< 12
100 kHz 500 kHz	Ref ± 0.2 dB	BW ± 10%	< 15	< 12
1 MHz to 2 MHz	Ref ± 0.3 dB	BW ± 10%	< 15	< 12
3 MHz	Ref ± 0.3 dB	BW ± 10%	< 7	< 7
5 MHz	Ref ± 0.3 dB	BW ± 15%	< 7	< 7
10 MHz	Ref ± 0.3 dB	BW -10% + 25%	< 7	< 7

5.2.7 Checking the Noise Display, LO Feedthrough

Test equipment: 50-Ω termination (section 5.1, item 6)

Test setup: Terminate the RF input of the FSE with 50 Ω.

Measurement

➢ FSE setting

RF ATT	0 dB
RBW	10 Hz
VBW	1 Hz
SPAN	0 Hz
TRACE	AVERAGE
SWEEP COUNT	30
SWEEPTIME	0.1 s
REF LVL	-10 dBm (for LO feedthrough)
REF LVL	-60 dBm (for noise display)

LO feedthrough

➢ Call calibration of LO compensation with model 30
[***SYSTEM CAL:*** *CAL LO SUP*]

➢ Set the center frequency to 0 Hz
[***FREQUENCY CENTER***] = 0 Hz

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off marker level (= LO feedthrough)

Model 20 ..... < -5 dBm
Model 30 ..... < -20 dBm

Noise display

➢ Set center frequency to frequency f_n (see table) [***FREQUENCY CENTER***]= f_n

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off marker level (= noise level)

➢ Check noise display for

Frequency f_n	FSEA20	FSEA30	FSEB20	FSEB30	FSEM20	FSEM30
20 Hz	-	<-80 dBm	-	<-74 dBm	-	<-74 dBm
1 kHz	-	<-110 dBm	-	<-104 dBm	-	<-104 dBm
10 kHz	<-90 dBm	<-125 dBm	<-84 dBm	<-119dBm	<-84 dBm	<-119dBm
100 kHz	<-110 dBm	<-135 dBm	<-104 dBm	<-129 dBm	<-104 dBm	<-129 dBm
1 MHz	<-130 dBm	<-145 dBm	<-125 dBm	<-142 dBm	<-124 dBm	<-142 dBm
10 MHz to 3.5 GHz	<-145 dBm	<-145 dBm	<-142 dBm	<-142 dBm	<-138 dBm	<-138 dBm
3.5 to 6.0 GHz			<-142 dBm	<-142 dBm	<-138 dBm	<-138 dBm
6.0 to 7 GHz			<-139 dBm	<-139 dBm	<-135 dBm	<-135 dBm
7 to 18 GHz					<-138 dBm	<-138 dBm
18 to 26.5 GHz					<-135 dBm	<-135 dBm

➢ Measure at the band limits and also at the three worst frequency points.
Search these points with [***FREQUENCY SPAN**: FULL SPAN*];
[***SWEEP COUPLING*** : *RES BW: 1 MHz* and *VIDEO BW: 1 kHz*].

5.2.8 Checking the Frequency Response

Test equipment

- Signal generator (section 5.1, item 2; item 3)
- Power meter (section 5.1, item 7)
- 6-dB splitter (section 5.1, item 5)

Test setup

Connect signal generator to the RF input of the FSE via the 6-dB divider.

Measurement

➢ Signal generator setting

- Level	-10 dBm
- Frequency f_{fresp}	1, 10, 50 MHz, 100 MHz, 120 MHz, every 100 MHz to FSEA: 3.5 GHz FSEB/FSEM: 7 GHz; FSEM: 26.5 GHz

➢ FSE setting

- RF ATT	10 dB
- REF LVL	-7 dBm
- RBW	5 kHz
- VBW	auto
- SPAN	15 kHz

➢ Measure the receiver frequency response at least at frequencies f_{fresp}:

Carry out a comparison test using power meter:

➢ Set center frequency to frequency f_{fresp}
[***FREQUENCY CENTER***] = f_{fresp}

➢ Set marker to maximum display level
[***MARKER SEARCH***: *PEAK*]

➢ Read off marker level

Note: *Activate the peaking function on the FSEM in the range 7 to 26.5 GHz prior to any measurement.*

Nominal level ..... level indication of power meter at f_{fresp}

Evaluation

The deviation between the level indication of the power meter and that of the FSE is the absolute error (only at 120 MHz).

Absolute error (120 MHz) ..... < ± 0.3 dB deviation

The deviation between the level indication of the power meter, the FSE and the absolute error is the frequency response of the FSE:

Frequency response = $level_{FSE}$ - $level_{powermeter}$ - absolute $error_{120\ MHz}$

➢ Checking of:

	Frequency response		
Frequency f_{resp}	**FSEA**	**FSEB**	**FSEM**
f < 1 GHz	< 0.5 dB	< 0.5 dB	< 0.5 dB
1 to 3.5 GHz	< 1 dB	< 1 dB	< 1 dB
3.5 to 7 GHz		< 1 dB	< 1 dB
7 to 18 GHz			< 2 dB
18 to 26.5 GHz			< 2.5 dB

5.2.9 Checking the Display Linearity

Test equipment

- Signal generator (section 5.1, item 2)
- Attenuator (section 5.1, item 10)

Test setup

Connect signal generator to the RF input of the FSE via the attenuator.

Measurement

➢ Signal generator setting

- Frequency	5 MHz
- Level	-4 dBm
Level at FSE input	-10 dBm

➢ FSE setting

- RF ATT	10 dB
- REF LVL	-10 dBm
RBW	3 kHz
VBW	100 Hz
SPAN	500 Hz
LVL RANGE	100 dB

Ref = 10dB below REF LVL (Ref = reference attenuation)

➢ Increase attenuator setting ATT to 50 dB in 2-dB steps.

➢ Set marker to maximum display level
*[**MARKER SEARCH**: PEAK]*

➢ Read off marker level.

Nominal level .....-10 dBm - (ATT - Ref)

- ➢ Increase attenuator setting ATT by 45 dB in 5-dB steps.
- ➢ Set marker to maximum display level
  [***MARKER SEARCH***: *PEAK]*
- ➢ Read off marker level.

  Nominal level .....-10dBm - (ATT - Ref)
- ➢ Checking of:

	Display error	
ATT	**Model 20**	**Model 30**
0 to -50 dB	< 0.3 dB	< 0.3 dB
-50 to -70 dB	< 0.5 dB	< 0.5 dB
-70 to -80 dB	< 1 dB	< 1 dB
-80 to -95 dB	-	< 1 dB

5.2.10 Checking the Attenuator

Test equipment
- Signal generator (section 5.1, item 2)
- Attenuator (section 5.1, item 10)

Test setup

Connect signal generator to the RF input of the FSE via the attenuator.

Measurement

- ➢ Signal generator setting
  - Frequency 5 MHz
  - Level -10 dBm
- ➢ Attenuator setting
  - ATT 60 dB
- ➢ FSE setting
  - CENTER 5 MHz
  - REF LVL -30 dBm
  - RF ATT 10 dB
  - SPAN 2 kHz
  - RBW 1 kHz
- ➢ Set signal generator level so that the FSE indicates -60.0 dBm
- ➢ Set FSE in accordance with the following table.
- ➢ Set marker to maximum display level
  [***MARKER SEARCH***: *PEAK]*
- ➢ Read off marker level.
  Nominal values.....see table

ATT	RF ATT	REF LVL	Marker level
70 dB	0 dB	-40 dBm	-70 ± 0.3 dBm
60 dB	10 dB	-30 dBm	-60 ± 0.3 dBm
50 dB	20 dB	-20 dBm	-50 ± 0.3 dBm
40 dB	30 dB	-10 dBm	-40 ± 0.3 dBm
30 dB	40 dB	0 dBm	-30 ± 0.3 dBm
20 dB	50 dB	+10 dBm	-20 ± 0.3 dBm
10 dB	60 dB	+20 dBm	-10 ± 0.3 dBm
0 dB	70 dB	+10 dBm	0 ± 0.3 dBm

5.2.11 Checking the IF Gain Switching

Test principle

The IF gain can be switched from 0 to 50 dB in the FSE. It can be modified at constant RF attenuation by altering the reference level. To prevent the IF gain errors to be mixed with the log amplifier error, it is determined by comparison using an external precision attenuator.

Test equipment

- Signal generator (section 5.1, item 2)
- Attenuator (section 5.1, item 10)

Test setup

Connect signal generator to the RF input of the FSE via the attenuator.

Measurement

➢ Signal generator setting
- Frequency 5 MHz
- Level -10 dBm

➢ Attenuator setting
- ATT 30 dB

➢ FSE setting
- CENTER 5 MHz
- REF LVL -30 dBm
- RF ATT 10 dB
- SPAN 2 kHz
- RBW 1 kHz

➢ Set the signal generator level so that the FSE indicates exactly -40,0 dBm.

➢ Set FSE in accordance with the following tables.

➢ Set marker to maximum display level
*[**MARKER SEARCH**: PEAK]*

➢ Read off marker level.
Nominal values..... see tables

10-dB gain steps:

ATT	REF LVL	Marker level
0 dB	0 dBm	-10 ± 0.2 dBm
10 dB	-10 dBm	-20 ± 0.2 dBm
20 dB	-20 dBm	-30 ± 0.2 dBm
30 dB	-30 dBm	-40 ± 0.2 dBm
40 dB	-40 dBm	-50 ± 0.2 dBm
50 dB	-50 dBm	-60 ± 0.2 dBm

1-dB gain steps:

ATT	REF LVL	Marker level
30 dB	-30 dBm	-40.0 ± 0.2 dBm
31 dB	-31 dBm	-41 ± 0.2 dBm
32 dB	-32 dBm	-42 ± 0.2 dBm
33 dB	-33 dBm	-43 ± 0.2 dBm
34 dB	-34 dBm	-44 ± 0.2 dBm
35 dB	-35 dBm	-45 ± 0.2 dBm
36 dB	-36 dBm	-46 ± 0.2 dBm
37 dB	-37 dBm	-47 ± 0.2 dBm
38 dB	-38 dBm	-48 ± 0.2 dBm
39 dB	-39 dBm	-49 ± 0.2 dBm

5.2.12 Checking the Phase Noise

Test equipment
- Signal generator (section 5.1, item 2)
- Attenuator (section 5.1, item 10)

Test setup

Connect signal generator to the RF input of the FSE.

Measurement

- Signal generator setting
  - Frequency 498 MHz
  - Level 0 dBm
- FSE setting
  - Trace Average
  - Sweep Count 10

Set up marker reference

- FSE setting
  - CENTER 498 MHz
  - REF LVL 0 dBm
  - RBW depening on offset (see table)
  - SPAN depending on offset (see table)
  - RF ATT 10 dB
- Set marker to maximum display level
  [***MARKER SEARCH***: *PEAK]*
- Switch on phase noise marker
  [***MARKER DELTA***: *PHASE NOISE]*

Measure phase noise

- FSE setting
  - CENTER 498 MHz + offset (see table)
  - REF LVL -20 dBm
  - RF ATT 0 dB
- Set phase noise marker to offset
  [***MARKER DELTA***: *DELTA]*
- Read off phase noise in dBc/Hz.
  Nominal values.....see table

			Phase noise			
Offset	**Span**	**RBW**	**FSEA20**	**FSEA30**	**FSEB20 /FSEM20**	**FSEB30 /FSEM30**
100 Hz	10 Hz	10 Hz	-	< -87 dBc/Hz		< -81 dBc/Hz
1 kHz	100 Hz	100 Hz	< -85 dBc/Hz	< -107 dBc/Hz	< -79 dBc/Hz	< -100 dBc/Hz
10 kHz	500 Hz	500 Hz	< -96 dBc/Hz	< -120 dBc/Hz	< -90dBc/Hz	< -114dBc/Hz
100 kHz	2 kHz	2 kHz	< -119 dBc/Hz	< -117 dBc/Hz	< -113 dBc/Hz	< -111 dBc/Hz
1 MHz	30 kHz	30 kHz	< -135 dBc/Hz	< -135 dBc/Hz	< -129 dBc/Hz	< -129 dBc/Hz

Notes: *To obtain a precise measurement of the phase noise, the level used at the FSE input is 20 dB higher than the reference level. To reduce the measurement time, the phase noise is measured with a small span around the frequency offset. This prevents the FSE from being overloaded.*
Model 20 with option B4 is checked in the same way as model 30.

5.3 Performance Test Report

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
1	Calibration source at 120 MHz	5.2.1	-40.3	_____	-39.7	dBm
2	Frequency accuracy Reference oscillator	5.2.2				
	Model 20		9.99999	_____	10.00001	MHz
	Model 30 or Model 20 with B4		9.999999	_____	10.000001	MHz
3	Return loss	5.2.3				
	RF input					
	FSEA:					
	RF ATT: 0 dB					
	1 MHz		6	_____	-	dB
	250 MHz		6	_____	-	dB
	500 MHz		6	_____	-	dB
	750 MHz		6	_____	-	dB
	1000 MHz		6	_____	-	dB
	1250 MHz		6	_____	-	dB
	1500 MHz		6	_____	-	dB
	1750 MHz		6	_____	-	dB
	2000 MHz		6	_____	-	dB
	2250 MHz		6	_____	-	dB
	2500 MHz		6	_____	-	dB
	2750 MHz		6	_____	-	dB
	3000 MHz		6	_____	-	dB
	3250 MHz		6	_____	-	dB
	3500 MHz		6	_____	-	dB
	RF ATT: 10 dB					
	1 MHz		14	_____	-	dB
	250 MHz		14	_____	-	dB
	500 MHz		14	_____	-	dB
	750 MHz		14	_____	-	dB
	1000 MHz		14	_____	-	dB
	1250 MHz		14	_____	-	dB
	1500 MHz		14	_____	-	dB
	1750 MHz		14	_____	-	dB
	2000 MHz		14	_____	-	dB
	2250 MHz		14	_____	-	dB
	2500 MHz		14	_____	-	dB
	2750 MHz		14	_____	-	dB
	3000 MHz		14	_____	-	dB
	3250 MHz		14	_____	-	dB
	3500 MHz		14	_____	-	dB

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
3	**FSEB / FSEM:**	5.2.3				
	RF ATT: 0 dB					
	1 MHz		6	———	-	dB
	250 MHz		6	———	-	dB
	500 MHz		6	———	-	dB
	750 MHz		6	———	-	dB
	1000 MHz		6	———	-	dB
	1250 MHz		6	———	-	dB
	1500 MHz		6	———	-	dB
	1750 MHz		6	———	-	dB
	2000 MHz		6	———	-	dB
	2250 MHz		6	———	-	dB
	2500 MHz		6	———	-	dB
	2750 MHz		6	———	-	dB
	3000 MHz		6	———	-	dB
	3250 MHz		6	———	-	dB
	3500 MHz		6	———	-	dB
	3750 MHz		5	———	-	dB
	4000 MHz		5	———	-	dB
	4250 MHz		5	———	-	dB
	4500 MHz		5	———	-	dB
	4750 MHz		5	———	-	dB
	5000 MHz		5	———	-	dB
	5250 MHz		5	———	-	dB
	5500 MHz		5	———	-	dB
	5750 MHz		5	———	-	dB
	6000 MHz		5	———	-	dB
	6250 MHz		5	———	-	dB
	6500 MHz		5	———	-	dB
	6750 MHz		5	———	-	dB
	RF ATT: 10 dB					
	1 MHz		14	———	-	dB
	250 MHz		14	———	-	dB
	500 MHz		14	———	-	dB
	750 MHz		14	———	-	dB
	1000 MHz		14	———	-	dB
	1250 MHz		14	———	-	dB
	1500 MHz		14	———	-	dB
	1750 MHz		14	———	-	dB
	2000 MHz		14	———	-	dB
	2250 MHz		14	———	-	dB
	2500 MHz		14	———	-	dB
	2750 MHz		14	———	-	dB
	3000 MHz		14	———	-	dB
	3250 MHz		14	———	-	dB
	3500 MHz		14	———	-	dB
	3750 MHz		9.5	———	-	dB
	4000 MHz		9.5	———	-	dB
	4250 MHz		9.5	———	-	dB
	4500 MHz		9.5	———	-	dB
	4750 MHz		9.5	———	-	dB
	5000 MHz		9.5	———	-	dB
	5250 MHz		9.5	———	-	dB
	5500 MHz		9.5	———	-	dB
	5750 MHz		9.5	———	-	dB
	6000 MHz		9.5	———	-	dB
	6250 MHz		9.5	———	-	dB
	6500 MHz		9.5	———	-	dB
	6750 MHz		9.5	———	-	dB

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
3	**FSEM:**	5.2.3				
	RF ATT: 10 dB					
	7000 MHz		6	———	-	dB
	8000 MHz		6	———	-	dB
	9000 MHz		6	———	-	dB
	10 GHz		6	———	-	dB
	11 GHz		6	———	-	dB
	12 GHz		6	———	-	dB
	13 GHz		6	———	-	dB
	14 GHz		6	———	-	dB
	15 GHz		6	———	-	dB
	16 GHz		6	———	-	dB
	17 GHz		6	———	-	dB
	18 GHz		6	———	-	dB
	19 GHz		6	———	-	dB
	20 GHz		6	———	-	dB
	21 GHz		6	———	-	dB
	22 GHz		6	———	-	dB
	23 GHz		6	———	-	dB
	24 GHz		6	———	-	dB
	25 GHz		6	———	-	dB
	26 GHz		6	———	-	dB
	26.5 GHz		6	———	-	dB
4	1st IF image frequency rejection f_{in}	5.2.4.1				
	11 MHz		80	———	-	dB
	100 MHz		80	———	-	dB
	1701 MHz		80	———	-	dB
	3499 MHz		80	———	-	dB
	6999 MHz		80	———	-	dB
5	2nd IF image frequency rejection f_{in}	5.2.4.2				
	999 MHz		80	———	-	dB
	7999 MHz		80	———	-	dB
6	1st IF rejection f_{in}	5.2.4.3	FSEA / FSEB			
	100 MHz		80 / 75	———	-	dB
	1701 MHz		80 ,/ 75	———	-	dB
	3500 MHz		80 / 75	———	-	dB

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
7	3rd-order intercept	5.2.5.1	FSEA / FSEB			
	f_{in}					
	10 MHz		7	———	-	dBm
	28 MHz		7	———	-	dBm
	106 MHz		12 / 7	———	-	dBm
	261 MHz		12	———	-	dBm
	640 MHz		12	———	-	dBm
	1 GHz		12	———	-	dBm
	1.7 GHZ		12	———	-	dBm
	2.5 GHz		12	———	-	dBm
	3.48 GHz		12	———	-	dBm
	6.98 GHz		12	———	-	dBm
	7.5 GHz		12	———	-	dBm
	15 GHz		12	———	-	dBm
	25 GHz		12	———	-	dBm
8	2nd-order intercept	5.2.5.2	FSEA / FSEB			
	f_{in}					
	9 kHz		25	———	-	dBm
	35 kHz		25	———	-	dBm
	99 kHz		25	———	-	dBm
	19 MHz		25	———	-	dBm
	28 MHz		25	———	-	dBm
	107 MHz		45 / 25	———	-	dBm
	262 MHz		45 / 40	———	-	dBm
	453 MHz		45 / 40	———	-	dBm
	640 MHz		45 / 40	———	-	dBm
	1 GHz		45 / 40	———	-	dBm
	1.25 GHz		45 / 40	———	-	dBm
	1.7 GHz		45 / 40	———	-	dBm
	3.4 GHz		45 / 40	———	-	dBm
9	IF bandwidths	5.2.6				
	3-dB bandwidth					
	100 Hz		-10 %-	———	+10 %	-
	1 kHz		-10 %-	———	+10 %	-
	2 kHz		-10 %-	———	+10 %	-
	3 kHz		-10 %-	———	+10 %	-
	5 kHz		-10 %-	———	+10 %	-
	10 kHz		-10 %-	———	+10 %	-
	20 kHz		-10 %-	———	+10 %	-
	30 kHz		-10 %-	———	+10 %	-
	50 kHz		-10 %-	———	+10 %	-
	100 kHz		-10 %-	———	+10 %	-
	200 kHz		-10 %-	———	+10 %	-
	300 kHz		-10 %-	———	+10 %	-
	500 kHz		-10 %-	———	+10 %	-
	1 MHz		-10 %-	———	+10 %	-
	2 MHz		-10 %-	———	+10 %	-
	3 MHz		-10 %-	———	+10 %	-
	5 MHz		-15 %-	———	+15 %	-
	10 MHz		-10 %-	———	+25 %	-

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
10	IF bandwidths	5.2.6			Mod. 20 / 30	
	Shape factor					
	100 Hz		-	———	6 / 6	-
	1 kHz		-	———	15 / 12	-
	2 kHz		-	———	5 / 12	-
	3 kHz		-	———	15 / 12	-
	5 kHz		-	———	15 / 12	-
	10 kHz		-	———	15 / 12	-
	20 kHz		-	———	15 / 12	-
	30 kHz		-	———	5 / 12	-
	50 kHz		-	———	15 / 12	-
	100 kHz		-	———	15 / 12	-
	200 kHz		-	———	15 / 12	-
	300 kHz		-	———	15 / 12	-
	500 kHz		-	———	5 / 12	-
	1 MHz		-	———	15 / 12	-
	2 MHz		-	———	15 / 12	-
	3 MHz		-	———	7 / 7	-
	5 MHz		-	———	7 / 7	-
	10 MHz		-	———	7 / 7	-
11	IF bandwidths	5.2.6				
	Level error					
	100 Hz		Ref - 0.2	———	Ref + 0.2	dB
	1 kHz		Ref - 0.2	———	Ref + 0.2	dB
	2 kHz		Ref - 0.2	———	Ref + 0.2	dB
	3 kHz		Ref - 0.2	reference (ref)	Ref + 0.2	dB
	5 kHz		-		-	dBm
	10 kHz		Ref - 0.2	———	Ref + 0.2	dB
	20 kHz		Ref - 0.2	———	Ref + 0.2	dB
	30 kHz		Ref - 0.2	———	Ref + 0.2	dB
	50 kHz		Ref - 0.6	———	Ref + 0.6	dB
	100 kHz		Ref - 0.2	———	Ref + 0.2	dB
	200 kHz		Ref - 0.2	———	Ref + 0.2	dB
	300 kHz		Ref - 0.2	———	Ref + 0.2	dB
	500 kHz		Ref - 0.2	———	Ref + 0.2	dB
	1 MHz		Ref - 0.2	———	Ref + 0.2	dB
	2 MHz		Ref - 0.2	———	Ref + 0.2	dB
	3 MHz		Ref - 0.3	———	Ref + 0.3	dB
	5 MHz		Ref - 0.3	———	Ref + 0.3	dB
	10 MHz		Ref - 0.3	———	Ref + 0.3	dB
12	LO feedthrough	5.2.7				
	Model 20		-	———	-5	dBm
	Model 30		-	———	-20	dBm

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
13	FSEA noise display	5.2.7			Mod. 20 / 30	
	f_n					
	20 Hz		-	_____	- / -80	dBm
	1 kHz		-	_____	- / -110	dBm
	9.9 kHz		-	_____	-90 / -125	dBm
	95 kHz		-	_____	-110 / -135	dBm
	999 kHz		-	_____	-130 / -145	dBm
	9.99 MHz		-	_____	-145 / -145	dBm
	19.99 MHz		-	_____	-145 / -145	dBm
	49.99 MHz		-	_____	-145 / -145	dBm
	99.99 MHz		-	_____	-145 / -145	dBm
	199.99 MHz		-	_____	-145 / -145	dBm
	499.99 MHz		-	_____	-145 / -145	dBm
	999.9 GHz		-	_____	-145 / -145	dBm
	1999.9 GHz		-	_____	-145 / -145	dBm
	3.499 GHz		-	_____	-145 / -145	dBm
	_____			_____		dBm
	_____			_____		dBm
	_____			_____		dBm
14	FSEB noise display	5.2.7			Mod. 20 / 30	
	f_n					
	20 Hz		-	_____	- / -70	dBm
	1 kHz		-	_____	- /-104	dBm
	9.9 kHz		-	_____	-84 / -119	dBm
	95 kHz		-	_____	-104 / -129	dBm
	999 kHz		-	_____	-125 / -142	dBm
	9.99 MHz		-	_____	-142 / -142	dBm
	19.99 MHz		-	_____	-142 / -142	dBm
	49.99 MHz		-	_____	-142 / -142	dBm
	99.99 MHz		-	_____	-142 / -142	dBm
	199.99 MHz		-	_____	-142 / -142	dBm
	499.99 MHz		-	_____	-142 / -142	dBm
	999.9 MHz		-	_____	-142 / -142	dBm
	1999.9 MHz		-	_____	-142 / -142	dBm
	3499.9 MHz		-	_____	-142 / -142	dBm
	5999.9 MHz		-	_____	-142 / -142	dBm
	6999.9 MHz		-	_____	-139 / -139	dBm
	_____			_____		dBm
	_____			_____		dBm
	_____			_____		dBm

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
15	FSEM noise display f_n	5.2.7			Mod. 20 / 30	
	20 Hz		-	_____	- / -70	dBm
	1 kHz		-	_____	- /-104	dBm
	9.9 kHz		-	_____	-84 / -119	dBm
	95 kHz		-	_____	-104 / -129	dBm
	999 kHz		-	_____	-124 / -142	dBm
	9.99 MHz		-	_____	-138 / -138	dBm
	19.99 MHz		-	_____	-138 / -138	dBm
	49.99 MHz		-	_____	-138 / -138	dBm
	99.99 MHz		-	_____	-138 / -138	dBm
	199.99 MHz		-	_____	-138 / -138	dBm
	499.99 MHz		-	_____	-138 / -138	dBm
	999.9 MHz		-	_____	-138 / -138	dBm
	1999.9 MHz		-	_____	-138 / -138	dBm
	3499.9 MHz		-	_____	-138 / -138	dBm
	5999.9 MHz		-	_____	-138 / -138	dBm
	6999.9 MHz		-	_____	-135 / -135	dBm
	7199.9 MHz		-	_____	-138 / -138	dBm
	11999.9 MHz		-	_____	-138 / -138	dBm
	17999.9 MHz		-	_____	-138 / -138	dBm
	21999.9 MHz		-	_____	-135 / -135	dBm
	26399.9 MHz		-	_____	-135 / -135	dBm
	_____			_____		dBm
	_____			_____		dBm
	_____			_____		dBm

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
16	Frequency response f_{fresp}	5.2.7				
	120 MHz (gives ref)		- 10.3 dBm	———	- 9.7 dBm	dBm
	1 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	10 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	50 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	100 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	200 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	300 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	400 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	500 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	600 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	700 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	800 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	900 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	1000 MHz		Ref - 0.5dB	———	Ref + 0.5dB	dBm
	1500 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	2000 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	2500 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	3000 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	3499 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	FSEB / M + freq.:					
	4000 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	4500 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	5000 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	5500 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	6000 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	6500 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	6999 MHz		Ref - 1dB	———	Ref + 1dB	dBm
	FSEM + freq.:					
	8000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	9000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	10000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	11000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	12000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	13000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	14000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	15000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	16000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	17000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	18000 MHz		Ref - 2dB	———	Ref + 2dB	dBm
	19000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	20000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	21000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	22000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	23000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	24000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	25000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	26000 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm
	26499 MHz		Ref - 2.5dB	———	Ref + 2.5dB	dBm

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
17	Display linearity	5.2.9				
	0 dB		-10.3	———	-9.7	dBm
	2 dB		-12.3	———	-11.7	dBm
	4 dB		-14.3	———	-13.7	dBm
	6 dB		-16.3	———	-15.7	dBm
	8 dB		-18.3	———	-17.7	dBm
	10 dB		-20.3	———	-19.7	dBm
	12 dB		-22.3	———	-21.7	dBm
	14 dB		-24.3	———	-23.7	dBm
	16 dB		-26.3	———	-25.7	dBm
	18 dB		-28.3	———	-27.7	dBm
	20 dB		-30.3	———	-29.7	dBm
	22 dB		-32.3	———	-31.7	dBm
	24 dB		-34.3	———	-33.7	dBm
	26 dB		-36.3	———	-35.7	dBm
	28 dB		-38.3	———	-37.7	dBm
	30 dB		-40.3	———	-39.7	dBm
	32 dB		-42.3	———	-41.7	dBm
	34 dB		-44.3	———	-43.7	dBm
	36 dB		-46.3	———	-45.7	dBm
	38 dB		-48.3	———	-47.7	dBm
	40 dB		-50.3	———	-49.7	dBm
	42 dB		-52.3	———	-51.7	dBm
	44 dB		-54.3	———	-53.7	dBm
	46 dB		-56.3	———	-55.7	dBm
	48 dB		-58.3	———	-57.7	dBm
	50 dB		-60.3	———	-59.7	dBm
	55 dB		-65.5	———	-64.5	dBm
	60 dB		-70.5	———	-69.5	dBm
	65 dB		-75.5	———	-74.5	dBm
	70 dB		-81	———	-79	dBm
	75 dB		-86	———	-84	dBm
	80 dB		-91	———	-89	dBm
	only models 30					
	85 dB		-96	———	-94	dBm
	90 dB		-101	———	-99	dBm
	95 dB		-106	———	-104	dBm
18	Attenuator	5.2.10				
	RF ATT					
	0		-70.3	———	-69.7	dBm
	10		-60.3	———	-59.7	dBm
	20		-50.3	———	-49.7	dBm
	30		-40.3	———	-39.7	dBm
	40		-30.3	———	-29.7	dBm
	50		-20.3	———	-19.7	dBm
	60		-10.3	———	-9.7	dBm
	70		-0.3	———	+0.3	dBm

Item No.	Characteristic	Test to section	Min. value	Actual value	Max. value	Unit
19	IF gain switching Reference level	5.2.11				
	0 dBm		-10.2	———	-9.8	dBm
	-10 dBm		-20.2	———	-19.8	dBm
	-20 dBm		-30.2	———	-29.8	dBm
	-30 dBm		-40.2	———	-39.8	dBm
	-40 dBm		-50.2	———	-49.8	dBm
	-50 dBm		-60.2	———	-59.8	dBm
	-31 dBm		-41.2	———	-40.8	dBm
	-32 dBm		-42.2	———	-41.8	dBm
	-33 dBm		-43.2	———	-42.8	dBm
	-34 dBm		-44.2	———	-43.8	dBm
	-35 dBm		-45.2	———	-44.8	dBm
	-36 dBm		-46.2	———	-45.8	dBm
	-37 dBm		-47.2	———	-46.8	dBm
	-38 dBm		-48.2	———	-47.8	dBm
	-39 dBm		-49.2	———	-48.8	dBm
20	Phase noise offset:	5.2.12				
	FSEA20:					
	1 kHz		-	———	-85	dBc/Hz
	10 kHz		-	———	-96	dBc/Hz
	100 kHz		-	———	-119	dBc/Hz
	1 MHz		-	———	-135	dBc/Hz
	FSEA30:					
	100 Hz		-	———	-87	dBc/Hz
	1 kHz		-	———	-107	dBc/Hz
	10 kHz		-	———	-120	dBc/Hz
	100 kHz		-	———	-117	dBc/Hz
	1 MHz		-	———	-135	dBc/Hz
	FSEB20:					
	1 kHz		-	———	-79	dBc/Hz
	10 kHz		-	———	-90	dBc/Hz
	100 kHz		-	———	-113	dBc/Hz
	1 MHz		-	———	-129	dBc/Hz
	FSEB30:					
	100 Hz		-	———	-81	dBc/Hz
	1 kHz		-	———	-100	dBc/Hz
	10 kHz		-	———	-114	dBc/Hz
	100 kHz		-	———	-111	dBc/Hz
	1 MHz		-	———	-129	dBc/Hz

Annex A - Interfaces

A.1 IEC Bus Interface

The standard spectrum analyzer is equipped with an optional IEC/IEEE Bus connector. An IEEE 488 interface connector is located on the rear panel of the FSE. An external controller for remote control of the spectrum analyzer can be connected via the IEEE 488 interface connector using a shielded cable.

A second, optional IEC Bus interface can be installed in the FSE and is, with an installed processor option, assigned to the MS-DOS processor. This interface can be controlled by standard software (R&S-Basic, QUICK-Basic, etc.) under MS-DOS as well as under WINDOWS (VISUAL BASIC, etc.) with the delivered driver software. The IEC Bus interface allows the remote control of the spectrum analyzer via an external connection to both IEC Bus interfaces and, in addition, the control of other instruments via the IEC Bus interface located on the rear panel (e.g., control of a complete measurement system).

The following section describes the first IEC Bus interface over which the spectrum analyzer can be remotely controlled. The characteristics of the PC2A/PC-AT controller interface depend upon the user-installed software running on the MS-DOS processor and is, therefore, not described here.

Interface Characteristics

- 8-bit parallel data transfer
- bidirectional data transfer
- three-line handshake
- high data transfer rate of max. 350 kbyte/s
- up to 15 instruments can be connected
- maximal length of the interconnecting cables 15 m (single connection, 2m)
- wired-OR connection if several instruments are connected in parallel.

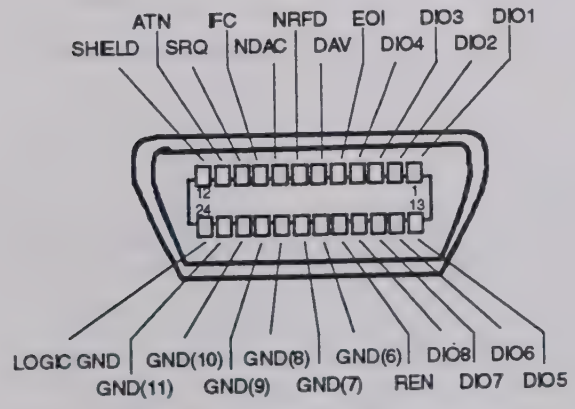


Fig. A-1 Pin assignment of IEC-Bus interface

Bus Lines

1. **Data bus with 8 lines DIO 1 to DIO 8.**
   The transmission is bit-parallel and byte-serial in the ASCII/ISO code. DIO1 is the least significant, DIO8 the most significant bit.

2. **Control bus with 5 lines.**
   IFC (Interface Clear),
   active low resets the interfaces of the devices connected to the default setting.

   ATN (Attention),
   active low signals the transmission of interface messages
   inactive high signals the transmission of device messages.

   SRQ (Service Request),
   active low enables a device connected to send a service request to the controller.

   REN (Remote Enable),
   active low permits the switch over to remote control.

   EOI (End or Identify),
   has two functions in connection with ATN:
   active low marks the end of data transmission when ATN=high
   active low triggers a parallel poll when ATN=low.

3. **Handshake bus with three lines.**
   DAV (Data Valid),
   active low signals a valid data byte on the data bus.

   NRFD (Not Ready For Data),
   active low signals that one of the devices connected is not ready for data transfer .

   NDAC (Not Data Accepted),
   active low as long as the device connected is accepting the data present on the data bus.

Interface Functions

Instruments which can be remote controlled via the IEC bus can be equipped with different interface functions. Table A-1 lists the interface functions appropriate for the instrument.

Table A-1 Interface functions

Control character	Interface function
SH1	Handshake source function (source handshake), full capability
AH1	Handshake sink function (acceptor handshake), full capability
L4	Listener function, full capability, deaddressed by MTA.
T6	Talker function, full capability, ability to respond to serial poll, deaddressed by MLA
SR1	Service request function (Service Request), full capability
PP1	Parallel poll function, full capability
RL1	Remote/Local switch over function, full capability
DC1	Reset function (Device Clear), full capability
DT1	Trigger function (Device Trigger), full capability
C12	Controller function, capability to send interface messages, to accept or relinquish the controller function

IEC Bus Messages

The messages transferred via the data lines of the IEC bus can be divided into two groups:

– **interface messages**
and
– **instrument messages.**

Interface Messages

Interface messages are transferred on the data lines of the IEC Bus when the "ATN" control line is active (LOW). They are used for communication between controller and instruments and can only be sent by the controller which currently has control of the IEC Bus.

Universal Commands

The universal commands are encoded 10 - 1F hex. They affect all instruments connected to the bus without addressing.

Table A-2 Universal Commands

Command	QuickBASIC command	Effect on the instrument
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument settings.
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default setting.
LLO (Local Lockout)	IBCMD (controller%, CHR$(17))	The LOC/IEC ADDR key is disabled.
SPE (Serial Poll Enable)	IBCMD (controller%, CHR$(24))	Ready for serial poll.
SPD (Serial Poll Disable)	IBCMD (controller%, CHR$(25))	End of serial poll.
PPU (Parallel Poll Unconfigure)	IBCMD (controller%, CHR$(21))	End of the parallel-poll state.

Addressed Commands

The addressed commands are encoded 00 - 0F hex. They are only effective for instruments addressed as listeners.

Table A-3 Addressed Commands

Command	QuickBASIC command	Effect on the instrument
SDC (Selected Device Clear)	IBCLR (device%)	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GTL (Go to Local)	IBLOC (device%)	Transition to the "Local" state (manual control).
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configure instrument for parallel poll. Additionally, the QuickBASIC command executes PPE/PPD.

Instrument Messages

Instrument messages are transferred on the data lines of the IEC bus when the "ATN" control line is not active. ASCII code is used.
Structure and syntax of the instrument messages are described in Chapter 3, Section 3.5. The commands are listed and explained in detail in Chapter 3, Section 3.6.

A.2 RS-232-C Interface

The standard FSE is equipped with two serial interfaces (RS-232-C). The RS-232-C interfaces are two independent, remote-control channels, both of which may be active at the same time. The programming and interrogation commands affect the same instrument hardware. The interfaces can be set up manually in the *SETUP-GENERAL SETUP* menu in the *COM PORT1/2* table or, via remote control, switched on/off with the command SYSTem:COMMunication:SERial1|2:STATe.

Each of the active RS-232-C interfaces is assigned to one of the 9-pin connectors located on the rear panel. Interface 1 is assigned to the connector COM1 and Interface 2 is assigned to the connector COM2.

Interface Characteristics

- Serial data transmission in asynchronous mode
- Bidirectional data transfer via two separate lines
- Transmission rate selectable from 110 to 19200 baud
- Logic '0' signal from+3 V to +15 V
- Logic '1' signal from -15 V to -3 V
- An external instrument (controller) can be connected.
- Software handshake (XON, XOFF)
- Hardware handshake

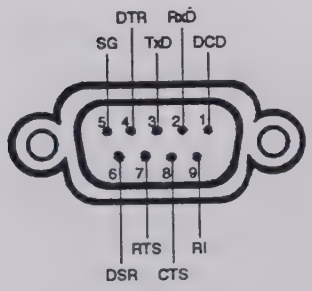


Fig. A-2 Pin assignment of the RS-232-C interface

Signal Lines

1. Data lines
The data transmission is bit-serial in ASCII code starting with the LSB. Two lines, **RxD** and **TxD** are necessary as the minimum requirement for transmission; however, no hardware handshake is possible. For handshaking, only the XON/XOFF software handshake protocol can be used .

RxD (Receive Data)
Input, LOW = logic '1', HIGH = logic '0'.
Data line, local terminal receives data from remote station.

TxD (Transmit Data)
Output, LOW = logic '1', HIGH = logic '0'.
Data line, local terminal transmits data to remote station.

2. Control lines

DCD (Data Carrier Detect),
Not used in FSE.
Input; active LOW.
Using this signal, the local terminal recognises that the modem of the remote station receives valid signals with sufficient level. DCD is used to disable the receiver in the local terminal and prevent reading of false data if the modem cannot interpret the signals of the remote station.

DTR (Data Terminal Ready),
Output, active LOW,
Indicates that the local terminal is ready to receive data.

DSR (Data Set Ready),
Input, active LOW,
Indicates that the remote station is ready to receive data.

RTS (Request To Send),
Output, active LOW.
Indicates that the local terminal wants to transmit data.

CTS (Clear To Send),
Input, active LOW.
Used to tell the local terminal that the remote station is ready to receive data.

RI (Ring Indicator),
Not used in FSE.
Input, active LOW.
Used by a modem to indicate that a remote station wants to establish a connection.

Transmission Parameters

To ensure error-free data transmission, the parameters of the instrument and the controller must have the same settings. The parameters are defined in the *SETUP-GENERAL SETUP* menu.

Transmission rate (baud rate)
the following transmission rates can be set in the analyzer:
110, 300, 600, 1200, 2400, 4800, 9600, 19200.

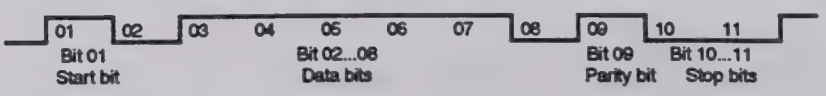
Data bits
Data transmission is in 7- or 8-bit ASCII code. The first bit transmitted is the LSB (least significant bit).

Start bit
Each data byte starts with a start bit. The falling edge of the start bit indicates the beginning of the data byte.

Parity bit
In order to detect errors, a parity bit may be transmitted. No parity, even parity or odd parity may be selected. In addition, the parity bit can be set to logic '0' or to logic '1'.

Stop bits
The transmission of a data byte is terminated by 1, 1,5 or 2 stop bits.

Example:
Transmission of character 'A' (41 hex) in 7-bit ASCII code, with even parity and 2 stop bits:



Interface Functions

For interface control, several strings are defined and control characters are reserved which are based upon IEC Bus control.

Table A-4 Control strings / characters defined for the RS-232 interface

Control string or character	Function
"@REM"	Switch over to remote
"@LOC"	Switch over to local
"@SRQ"	Service Request SRQ (SRQ is sent by the instrument)
"@GET"	Group Execute Trigger (GET)
"@DCL"	Reset instrument (Device Clear DCL)
<Ctrl Q> 11 Hex	Enables character output
<Ctrl S> 13 Hex	Inhibits character output
0D Hex, 0A Hex	Terminator <CR>, <LF>

Handshake

Software handshake

In the software handshake mode of operation, the data transfer is controlled using the two control characters XON / XOFF.

The instrument uses the control character XON to indicate that it is ready to receive data. If the receive buffer is full, it sends the XOFF character via the interface to the controller. The controller then interrupts the data output until it receives another XON from the instrument. The controller indicates to the instrument that it is ready to receive data in the same way.

Cable required for software handshake

The connection of the instrument with a controller for software handshake is made by crossing the data lines. The following wiring diagram applies to a controller with a 9-pin or 25-pin configuration.

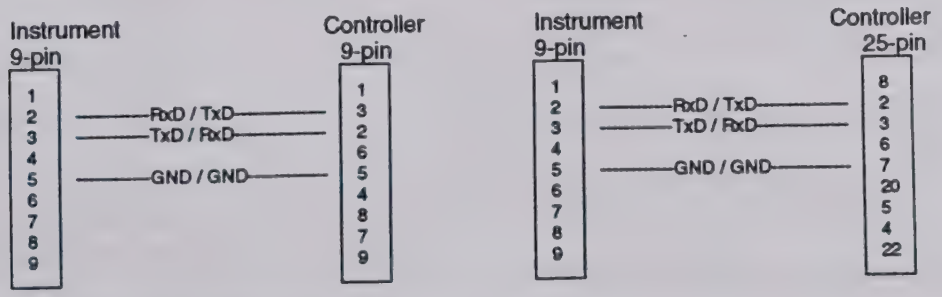


Fig. A-3 Wiring of the data lines for software handshake

Hardware handshake

For hardware handshake, the instrument indicates that it is ready to receive data via the lines DTR and RTS. A logic '0' on both lines means "ready" and a logic '1' means "not ready". The RTS line is always active (logic '0') as long as the serial interface is switched on. The DTR line thus controls the readiness of the instrument to receive data.

The readiness of the remote station to receive data is reported to the instrument via the CTS and DSR line. A logic '0' on both lines activates the data output and a logic '1' on both lines stops the data output of the instrument. The data output takes place via the TxD line.

Cable for hardware handshake

The connection of the instrument to a controller is made with a so-called zero modem cable. Here, the data, control and acknowledge lines must be crossed. The following wiring diagram applies to a controller with a 9-pin or 25-pin configuration.

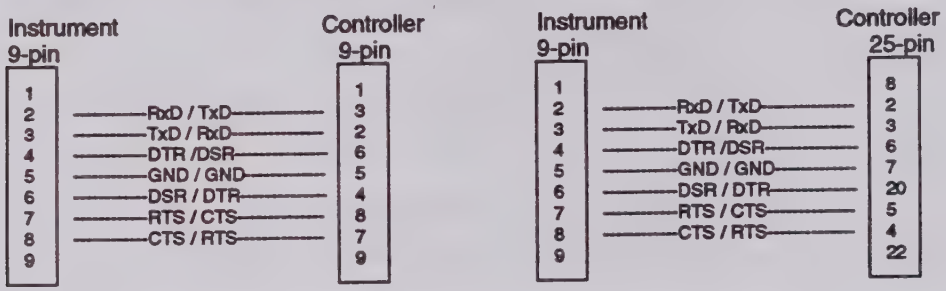


Fig. A-4 Wiring of the data, control and acknowledge lines for hardware handshake

A.3 User Interface (USER)

The user interface, located on the rear panel of the FSE, is a 25 pin Cannon connector which provides access to the two user ports (Port A and Port B). Each port is 8 bits wide (A0 - A7 and B0 -B7) and can be configured either as output or as input. The voltage levels are TTL levels (Low < 0,4 V, High > 2 V).

In addition, an internal +5 V power supply voltage is provided. The maximum load current is 100 mA.

The pin assignments for the USER connector can be seen in the following diagram:

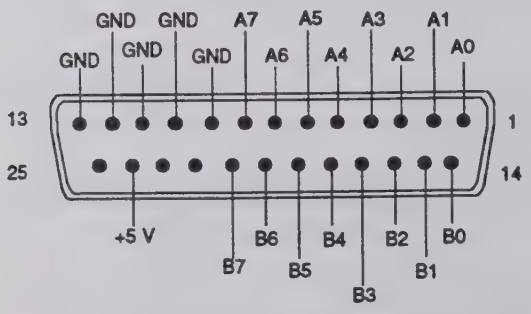
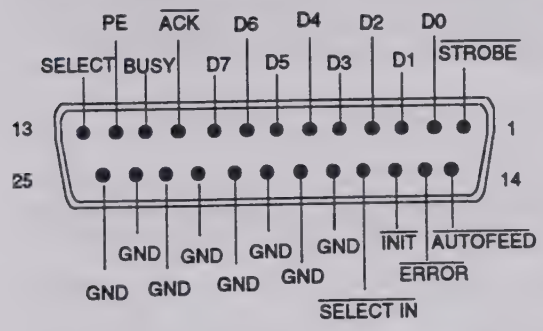


Fig. A-5 Pin assignments for the USER connector.

The configuration of the user ports takes place in the *SETUP* menu (SETUP key) in the *GENERAL SETUP* sub-menu.

A.4 Printer Interface (LPT)

The 25-pin LPT connector on the rear panel of the FSE is provided for the connection of a printer.. The LPT interface is compatible with the CENTRONICS printer interface.



Pin	Signal	Input (I) Output (O)	Description
1	STROBE	O	Pulse for transmitting a data byte, min. 1µs pulse width (active LOW)
2	D0	O	Data Line 0
3	D1	O	Data Line 1
4	D2	O	Data Line 2
5	D3	O	Data Line 3
6	D4	O	Data Line 4
7	D5	O	Data Line 5
8	D6	O	Data Line 6
9	D7	O	Data Line 7
10	ACK	I	Indicates that the printer is ready to receive the next byte. (active LOW)
11	BUSY	I	Signal is active when the printer cannot accept data. (active HIGH)
12	PE	I	Signal is active when the paper tray is empty. (active HIGH)
13	SELECT	I	Signal is active when the printer is selected. (active HIGH)
14	AUTOFEED	O	When signal is active, the printer automatically performs a linefeed after each line. (active LOW)
15	ERROR	I	This signal is high when the printer has no paper, is not selected or has an error status. (active LOW)
16	INIT	O	Initialise the printer. (active LOW)
17	SELECT IN	O	If signal is active, the codes DC1/DC3 are ignored by the printer. (active LOW).
18 - 25	GND		Ground connection.

Fig. A-6 Pin assignments for the LPT connector.

A.5 Measurement Converters (PROBE CODE)

The PROBE CODE connector is used for supplying power to measurement converters and the providing the correct conversion factor coding to the FSE. Using it, the conversion factors for high-impedance probes, current converters and antennas can be encoded in 10dB steps. In addition, the quantity to be measured (field strength, current and voltage) is also passed to the FSE. Active converters can be supplied with ±10 V via the PROBE CODE connector. The following R&S accessories are deliverable with the applicable coding:

- Wide band dipole 20...80 MHz HUF-Z2
- HF current converter 100 kHz..30 MHz ESH2-Z1
- VHF current converter 20...300 MHz ESV-Z1
- Current converter 20 Hz...100 MHz EZ-17
- Preamplifier 20...1000 MHz ESV-Z2.

The pins of the PROBE CODE connector are assigned as follows:

A ground
B +10 V, max. 50 mA
C µV/m (elec. field strength)
D µA
E 10 dB
F 20 dB
G 40 dB
H 80 dB
K -10 V, max. 50 mA
M factor sign inversion

Fig A.-7 Pin assignment for the 12-pin Tuchel connector.

A 12-pin connector is used for coding (manufacturer: Tuchel, R&S part number 0018.5362.00, Tuchel type number: T3635/2). The input pins for implementing the code are connected to ground.

Example: An antenna for measurement of the electromagnetic field strength has an antenna factor of 10 dB, i.e., a field strength of 10 dBµV/m produces a voltage at the RF input of 0 dBµV.

-> Pins C and E are connected to ground.

A.6 Probe Connector (PROBE POWER)

To allow the connection of probes, the FSE provides the PROBE POWER power connector. It delivers the power supply voltages +15 V and -12,6 V and ground.

The connector is also suited for powering the high-impedance probes from Hewlett Packard.

A.7 AF-Output (AF OUTPUT)

A miniature telephone jack can be used at the AF OUTPUT connector to connect an external loudspeaker, a headphone set or, e.g., a LF voltmeter. The internal resistance is 10 ohms and the output voltage is greater than 1.5 V RMS. When a jack is plugged in, the internal loudspeaker is automatically turned off.

A.8 IF Output 21.4 MHz (21.4 MHz OUT)

The 21,4 MHz IF signal of the FSE is available at the IF 21.4 MHz OUT BNC connector. The bandwidth corresponds to the selected bandwidth for a resolution bandwidth between 2 kHz and 10 MHz. For a resolution bandwidth below 2 kHz, the bandwidth of the output is 5 kHz.

The signal level at the IF output is 0 dBm for signals which correspond to the selected reference level.

A.9 Video Output (VIDEO OUT)

The video output delivers the logarithmic envelope curve of the IF signal independent of the level scaling on the display screen (linear or logarithmic). The bandwidth of the video signal always corresponds to one-half of the IF bandwidth and is not limited by the video filter in the measurement path.

A.10 Reference Output/Input (EXT REF IN/OUT)

When the FSE is operated with the internal reference, the internal 10 MHz reference signal is also available at the REF IN/OUT connector and thus provides the capability of, e.g., synchronisation of external instruments to the FSE. The level is 1 V RMS at 50 ohms source impedance.

For operation with an external reference, this connector becomes an input connector. The internal reference oscillator is then synchronised to the reference applied to the connector. The reference frequency can be between 1 and 16 MHz in 1 MHz steps. The necessary level is > 0 dBm.

The selection of internal or external references takes place in the *SETUP* menu.

A.11 Sweep Output (SWEEP)

The SWEEP BNC connector delivers a saw-tooth voltage between - 5V and + 5 V which, for the frequency spectrum display, is proportional to the instantaneous frequency. The selected start frequency corresponds to a voltage of -5 V and the stop frequency corresponds to a voltage of +5 V.

A.12 External Trigger Input (EXT TRIGGER/GATE)

The EXT TRIG/GATE connector is used for controlling the measurement via an external signal.

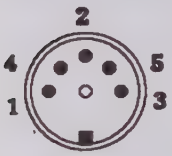
Trigger voltage range:: -5 V ... +5 V

A.13 Noise Source Control (NOISE SOURCE)

Using the NOISE SOURCE connector, an external noise source can be switched on/off, in order, e.g., to measure the noise figure of Units Under Test (UUTs). Usual noise sources require a +28 V signal to be turned on. At 0 V, they are turned off. These switching voltages are delivered by the connector.

A.14 External Keyboard (KEYBOARD)

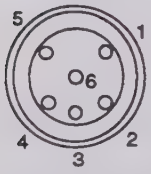
A 5-pin DIN connector is provided to allow connecting an external keyboard. Because of its low interference radiation, the PSA-Z1 keyboard is recommended (Order No. 1009.5001.31). However, any other multi-function keyboard may also be used.



Pin	Signal
1	Keyboard Clock
2	Data
3	Free
4	Ground
5	+5-V-Power Supply

Fig. A-8 Pin assignments of the KEYBOARD connector.

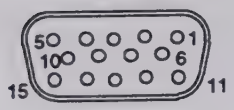
A.15 Mouse Connector (MOUSE)



Pin	Signal
1	MOUSECLK
2	MOUSEGND
3	MOUSEDATA
4	MOUSEVD5
5	NC
6	NC

Fig A-9 Pin assignments for the MOUSE connector.

A.16 Monitor Connector (MONITOR)



Pin	Signal
1	R
2	G
3	B
4	MID2
5	NC
6	R-GND
7	G-GND
8	B-GND
9	NC
10	GND
11	MID0
12	MID1
13	HSYNC
14	VSYNC
15	NC

Fig. A-10 Pin assignments of the MONITOR connector.

Annex B – List of Error Messages

The following list contains all error messages for errors occurring in the instrument. The meaning of negative error codes is defined in SCPI, positive error codes mark errors specific of the instrument.

The table contains the error code in the left-hand column. In the right-hand column the error text being entered into the error/event queue or being displayed is printed in bold face. Below the error text, there is an explanation as to the respective error.

B.1 SCPI-Specific Error Messages

No Error

Error code	Error text in the case of queue poll Error explanation
0	**No error** This message is output if the error queue does not contain any entries.

Command Error - Faulty command; sets bit 5 in the ESR register.

Error code	Error text in the case of queue poll Error explanation
-100	**Command Error** The command is faulty or invalid.
-101	**Invalid Character** The command contains an invalid sign. Example: A header contains an ampersand, "`SENSe&`".
-102	**Syntax error** The command is invalid. Example: The command contains block data the instrument does not accept.
-103	**Invalid separator** The command contains an impermissible sign instead of a separator. Example: A semicolon is missing after the command.
-104	**Data type error** The command contains an invalid value indication. Example: ON is indicated instead of a numeric value for frequency setting.
-105	**GET not allowed** A Group Execute Trigger (GET) is within a command line.
-108	**Parameter not allowed** The command contains too many parameters. Example: Command `SENSe:FREQuency:CENTer` permits only one frequency indication.

Continuation: Command Error

Error code	Error text in the case of queue poll Error explanation
-109	**Missing parameter** The command contains too few parameters. Example: The command `SENSe:FREQuency:CENTer` requires a frequency indication.
-110	**Command header error** The header of the command is faulty.
-111	**Header separator error** The header contains an impermissible separator. Example: the header is not followed by a "White Space", `"*ESE255"`
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is not defined for the instrument. Example: `*XYZ` is undefined for every instrument.
-114	**Header suffix out of range** The header contains an impermissible numeric suffix. Example: `SENSe3` does not exist in the instrument.
-120	**Numeric data error** The command contains a faulty numeric parameter.
-121	**Invalid character in number** A number contains an invalid character. Example: An "A" in a decimal number or a "9" in an octal number.
-123	**Exponent too large** The absolute value of the exponent is greater than 32000.
-124	**Too many digits** The number includes too many digits.
-128	**Numeric data not allowed** The command includes a number which is not allowed at this position. Example: The command `INPut:COUPling` requires indication of a text parameter.
-130	**Suffix error** The command contains a faulty suffix.
-131	**Invalid suffix** The suffix is invalid for this instrument. Example: nHz is not defined.
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix is not allowed for this command or at this position of the command. Example: The command `*RCL` does not permit a suffix to be indicated.
-140	**Character data error** The command contains a faulty text parameter
-141	**Invalid character data** The text parameter either contains an invalid character or it is invalid for this command. Example: Write error with parameter indication;`INPut:COUPling XC`.

Continuation: Command Error

Error code	Error text in the case of queue poll Error explanation
-144	**Character data too long** The text parameter contains more than 12 characters.
-148	**Character data not allowed** The text parameter is not allowed for this command or at this position of the command. Example: The command `*RCL` requires a number to be indicated.
-150	**String data error** The command contains a faulty string.
-151	**Invalid string data** The command contains a faulty string. Example: An END message has been received prior to the terminating apostrophe.
-158	**String data not allowed** The command contains a valid string at a position which is not allowed. Example: A text parameter is set in quotation marks, `INPut:COUPling "DC"`
-160	**Block data error** The command contains faulty block data.
-161	**Invalid block data** The command contains faulty block data. Example: An END message was received prior to reception of the expected number of data.
-168	**Block data not allowed** The command contains valid block data at an impermissible position. Example: The command `*RCL` requires a number to be indicated.
-170	**Expression error** The command contains an invalid mathematical expression.
-171	**Invalid expression** The command contains an invalid mathematical expression. Example: The expression contains mismatching parentheses.
-178	**Expression data not allowed** The command contains a mathematical expression at an impermissible position.
-180	**Macro error** A faulty macro has been defined, or an error has occurred during execution of a macro.
-181	**Invalid outside macro definition** A macro parameter placeholder was encountered outside of a macro definition.
-183	**Invalid inside macro definition** A macro definition is syntactically wrong.
-184	**Macro parameter error** A command inside the macro definition has the wrong number or type of parameters.

Execution Error - Error on execution of a command; sets bit 4 in the ESR register

Error code	Error text in the case of queue poll Error explanation
-200	**Execution error** Error on execution of the command.
-201	**Invalid while in local** The command is not executable while the device is in local due to a hard local control. Example: The device receives a command which would change the rotary knob state, but the device is in local so the command can not be executed.
-202	**Settings lost due to rtl** A setting associated with hard local control was lost when the device changed to LOCS from REMS or to LWLS from RWLS.
-210	**Trigger error** Error on triggering the device.
-211	**Trigger ignored** The trigger (GET, *TRG or trigger signal) was ignored because of device timing considerations. Example: The device was not ready to respond.
-212	**Arm ignored** An arming signal was ignored by the device.
-213	**Init ignored** Measurement initialisation was ignored as another measurement was already in progress.
-214	**Trigger deadlock** The trigger source for the initiation of measurement is set to GET and subsequent measurement is received. The measurement cannot be started until a GET is received, but the GET would cause an interrupted-error)
-215	**Arm deadlock** The trigger source for the initiation of measurement is set to GET and subsequent measurement is received. The measurement cannot be started until a GET is received, but the GET would cause an interrupted-error.
-220	**Parameter error** The command contains a faulty or invalid parameter.
-221	**Settings conflict** There is a conflict between setting of parameter value and instrument state.
-222	**Data out of range** The parameter value lies out of the permissible range of the instrument.
-223	**Too much data** The command contains too many data. Example: The instrument does not have sufficient storage space.
-224	**Illegal parameter value** The parameter value is invalid. Example: The text parameter is invalid , `TRIGger:SWEep:SOURce TASTe`

Continuation: Execution Error

Error code	Error text in the case of queue poll Error explanation
-230	**Data corrupt or stale** The data are incomplete or invalid. Example: The instrument has aborted a measurement.
-231	**Data questionable** The measurement accuracy is suspect.
-240	**Hardware error** The command cannot be executed due to problems with the instrument hardware.
-241	**Hardware missing** Hardware is missing. Example: An option is not fitted.
-250	**Mass storage error** A mass storage error occured.
-251	**Missing mass storage** The mass storage is missing. Example: An option is not installed.
-252	**Missing media** The media is missing. Example: There is no floppy in the floppy disk drive.
-253	**Corrupt media** The media is corrupt. Example: The floppy is bad or has the wrong format.
-254	**Media full** The media is full. Example: There is no room on the floppy.
-255	**Directory full** The media directory is full.
-256	**File name not found** The file name cannot be found on the media.
-257	**File name error** The file name is wrong. Example: An attempt is made to copy to a duplicate file name.
-258	**Media protected** The media is protected. Example: The write-protect tab on the floppy is present.
-260	**Expression error** The expression contains an error.
-261	**Math error in expression** The expression contains a math error. Example: Divide-by-zero.

Continuation: Execution Error

Error code	Error text in the case of queue poll Error explanation
-270	**Macro error** Error on the execution of a macro.
-271	**Macro syntax error** The macro definition contains a syntax error.
-272	**Macro execution error** The macro definition contains an error.
-273	**Illegal macro label** An illegal macro label is defined in the *DMC command. Example: The label is too long. The label is identical with the common command header or contains an invalid header syntax.
-274	**Macro parameter error** The macro definition improperly uses a macro parameter placeholder.
-275	**Macro definition too long** The macro definition is too long.
-276	**Macro recursion error** The command sequence defined by the macro is trapped in a program loop. Example: The event that would allow the loop to be exited does not occur.
-277	**Macro redefinition not allowed** The macro label defined in the *DMC command is already defined elsewhere.
-278	**Macro header not found** The macro label in the *GMC? query is not yet defined.
-280	**Program error** Error on the execution of a down-loaded program.
-281	**Cannot create program** The program cannot be created.
-282	**Illegal program name** The name of the programm is illegal. Example: The name relates to a non-existing program.
-283	**Illegal variable name** The inputted variable does not exist in the program.
-284	**Program currently running** The desired operation is not possible while the program is running. Example: A running program cannot be deleted.
-285	**Program syntax error** The down-loaded program contains a syntax error.
-286	**Program runtime error**

Device Specific Error; sets bit 3 in the ESR register

Error code	Error text in the case of queue poll Error explanation
-300	**Device-specific error** FSE-specific error not defined in greater detail.
-310	**System error** This error message suggests an error within the instrument. Please inform the R&S Service.
-311	**Memory error** Error in the instrument memory.
-312	**PUD memory lost** Loss of the protected user data stored using the *PUD command.
-313	**Calibration memory lost** Loss of the non-volatile calibration data stored using the *CAL? command.
-314	**Save/recall memory lost** Loss of the non-volatile data stored using the *SAV command.
-315	**Configuration memory lost** Loss of the non-volatile configuration data stored by the instrument.
-330	**Self-test failed** The selftest could not be executed.
-350	**Queue overflow** This error code is entered in the queue instead of the actual error code if the queue is full. It indicates that an error has occurred but not been accepted. The queue can accept 5 entries.

Query Error - Error in data request; sets bit 2 in the ESR register

Error code	Error text in the case of queue poll Error explanation
-400	**Query error** General error occurring when data are requested by a query.
-410	**Query INTERRUPTED** The query has been interrupted. Example: After a query, the instrument receives new data before the response has been sent completely.
-420	**Query UNTERMINATED** The query is incomplete. Example: The instrument is addressed as a talker and receives incomplete data.
-430	**Query DEADLOCKED** The query cannot be processed. Example: The input and output buffers are full, the instrument cannot continue operation.
-440	**Query UNTERMINATED after indefinite response** A query is in the same command line after a query which requests an indefinite response.

Annex C – List of Commands

Command	Parameter	Page
ABORt		3.6-7
CALCulate[1|2]:DELTamarker[1 to 4][:STATe]	ON | OFF	3.6-8
CALCulate[1|2]:DELTamarker[1...4]:MODE	ABSolute | RELativ	3.6-9
CALCulate[1|2]:DELTamarker[1 to 4]:AOFF		3.6-9
CALCulate[1|2]:DELTamarker[1 to 4]:TRACe	1 to 4	3.6-9
CALCulate[1|2]:DELTamarker[1 to 4]:X	0 to MAX (frequency) | MAX (sweep time)	3.6-9
CALCulate[1|2]:DELTamarker[1 to 4]:Y?		3.6-9
CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum[:PEAK]		3.6-10
CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:NEXT		3.6-10
CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:RIGHt		3.6-10
CALCulate[1|2]:DELTamarker[1 to 4]:MAXimum:LEFT		3.6-10
CALCulate[1|2]:DELTamarker[1 to 4]:MINimum[:PEAK]		3.6-10
CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:NEXT		3.6-11
CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:RIGHt		3.6-11
CALCulate[1|2]:DELTamarker[1 to 4]:MINimum:LEFT		3.6-11
CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed[:STATe]	ON | OFF	3.6-11
CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:Y		3.6-11
CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:Y:OFFSet		3.6-12
CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:FIXed:RPOint:X		3.6-12
CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:PNOise[:STATe]	ON | OFF	3.6-12
CALCulate[1|2]:DELTamarker[1 to 4]:FUNCtion:PNOise:RESult?		3.6-12
CALCulate[1|2]:DELTamarker[1 to 4]:STEP[:INCRement]		3.6-13
CALCulate[1|2]:DELTamarker[1 to 4]:STEP:AUTO	ON | OFF	3.6-13
CALCulate[1|2]:DLINe[1|2]	MIN to MAX (depending on current unit)	3.6-14
CALCulate[1|2]:DLINe[1|2]:STATe	ON | OFF	3.6-14
CALCulate[1|2]:FEED	'XTIM:DDEM:MEAS' | 'XTIM:DDEM:REF' | 'XTIM:DDEM:ERR:MPH' | 'XTIM:DDEM:ERR:VECT' | 'XTIM:DDEM:SYMB' | 'TCAP'	3.6-17
CALCulate[1|2]:FLINe[1|2]	0 GHz to fmax	3.6-15
CALCulate[1|2]:FLINe[1|2]:STATe	ON | OFF	3.6-15
CALCulate[1|2]:FORMat	MAGNitude | PHASe | UPHase | RIMag | FREQuency | IEYE | QEYE | TEYE | COMP | CONS	3.6-18

Command	Parameter	Page
CALCulate[1|2]:LIMit:CLEar[:IMMediate]		3.6-21
CALCulate[1|2]:LIMit:CONTrol[:DATA]		3.6-19
CALCulate[1|2]:LIMit:CONTrol:DOMain	FREQuency | TIME	3.6-20
CALCulate[1|2]:LIMit:FAIL?		3.6-21
CALCulate[1|2]:LIMit:LOWer[:DATA]		3.6-20
CALCulate[1|2]:LIMit:LOWer:STATe	ON | OFF	3.6-20
CALCulate[1|2]:LIMit:UPPer[:DATA]		3.6-20
CALCulate[1|2]:LIMit:UPPer:STATe	ON | OFF	3.6-20
CALCulate[1|2]:LIMit:STATe	ON | OFF	3.6-19
CALCulate[1|2]:MARKer[1 to 4]:AOFF		3.6-23
CALCulate[1|2]:MARKer[1 to 4]:COUNt	ON | OFF	3.6-23
CALCulate[1|2]:MARKer[1 to 4]:COUNt:RESolution	0.1 | 1 | 10 | 100 | 1000 | 10000 Hz	3.6-24
CALCulate[1|2]:MARKer[1 to 4]:COUNt:FREQuency?		3.6-24
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation:SELect	AM | FM	3.6-27
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation[:STATe]	ON | OFF	3.6-28
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:DEModulation:HOLDoff	10ms to 1000s	3.6-28
CALCulate[1|2]:MARKer[1...4]:FUNCtion:DDEMod:RESult?	MERM | MEPK | MEPS | PERM | PEPK | PEPS | EVRM | EVPK | EVPS | IQOF |ADR | FERR	3.6-29
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown		3.6-26
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown:STATe	ON | OFF	3.6-26
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NDBDown:RESult?		3.6-26
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:ZOOM		3.6-27
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NOISe[:STATe]	ON | OFF	3.6-27
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:NOISe:RESult?		3.6-27
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor	(60dB/3dB) | (60dB/6dB)	3.6-28
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor:STATe	ON | OFF	3.6-28
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:SFACtor:RESult?		3.6-29
CALCulate[1|2]:MARKer[1 to 4]:FUNCtion:STRack[:STATe]	ON | OFF	3.6-29
CALCulate[1|2]:MARKer[1 to 4]:MAXimum[:PEAK]		3.6-24
CALCulate[1|2]:MARKer[1 to 4]:MAXimum:NEXT		3.6-24
CALCulate[1|2]:MARKer[1 to 4]:MAXimum:RIGHt		3.6-25
CALCulate[1|2]:MARKer[1 to 4]:MAXimum:LEFT		3.6-25

Command	Parameter	Page
CALCulate[1|2]:MARKer[1 to 4][:STATe]	ON | OFF	3.6-23
CALCulate[1|2]:MARKer[1 to 4]:MINimum[:PEAK]		3.6-25
CALCulate[1|2]:MARKer[1 to 4]:MINimum:NEXT		3.6-25
CALCulate[1|2]:MARKer[1 to 4]:MINimum:RIGHt		3.6-25
CALCulate[1|2]:MARKer[1 to 4]:MINimum:LEFT		3.6-26
CALCulate[1|2]:MARKer[1...4]:READout	MPHase | RIMaginary	3.6-29
CALCulate[1|2]:MARKer[1 to 4]:STEP[:INCRement]		3.6-30
CALCulate[1|2]:MARKer[1 to 4]:STEP:AUTO	ON | OFF	3.6-30
CALCulate[1|2]:MARKer[1 to 4]:TRACe	1 to 4	3.6-23
CALCulate[1|2]:MARKer[1 to 4]:X	0 to MAX (frequency) | MAX (sweep time)	3.6-23
CALCulate[1|2]:MARKer[1 to 4]:Y?		3.6-24
CALCulate[1|2]:RLINe	MIN to MAX (depending on current unit)	3.6-15
CALCulate[1|2]:RLINe:STATe	ON | OFF	3.6-15
CALCulate[1|2]:THReshold	MIN to MAX (depending on current unit)	3.6-14
CALCulate[1|2]:THReshold:STATe	ON | OFF	3.6-15
CALCulate[1|2]:TLINe[1|2]	0 to 1000s	3.6-16
CALCulate[1|2]:TLINe[1|2]:STATe	ON | OFF	3.6-16
CALibration[:ALL]		3.6-31
CALibration:BANDwidth| BWIDth[:RESolution?]		3.6-31
CALibration:IQ?		3.6-31
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Command	Parameter	Page
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HCOPy:DEVice:ITEM:FFEed[1|2]:STATe	ON | OFF	3.6-40
HCOPy:DEVice:ITEM:LABel:TEXT	<string>	3.6-41
HCOPy:DEVice:ITEM:PFEed[1|2]:STATe	ON | OFF	3.6-41
HCOPy:DEVice:ITEM:WINDow[1|2]:TABle:STATe	ON | OFF	3.6-41
HCOPy:DEVice:ITEM:WINDow[1|2]:TEXT	<string>	3.6-41
HCOPy:DEVice:ITEM:WINDow[1|2]:TRACe:STATe	ON | OFF	3.6-41
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HCOPy:PAGE:ORIentation[1|2]	LANDscape | PORTrait	3.6-42
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MMEMory:LOAD:STATe	path, file name	3.6-49
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MMEMory:MSIS	'A:' | 'C:'	3.6-50
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MMEMory:STORe:STATe	path, file name	3.6-50
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[SENSe]:AVERage:COUNt	0 to 256	3.6-52
[SENSe]:AVERage:AUTO	ON | OFF	3.6-52
[SENSe]:AVERage[:STATe]	ON | OFF	3.6-52
[SENSe]:AVERage:TYPE	MAXimum | SCALar	3.6-53
[SENSe]:BANDwidth|BWIDth[:RESolution]	1Hz to 10 MHz (model 30) or 10 Hz to 10 MHz (model 20)	3.6-54
[SENSe]:BANDwidth|BWIDth[:RESolution]:AUTO	ON | OFF	3.6-54
[SENSe]:BANDwidth|BWIDth[:RESolution]:MODE	ANALog | DIGital	3.6-55
[SENSe]:BANDwidth|BWIDth:VIDeo	1Hz to 10 MHz	3.6-55
[SENSe]:BANDwidth|BWIDth:VIDeo:AUTO	ON | OFF	3.6-55
[SENSe]:DETector[:FUNCtion]	NEGative | POSitive | SAMPle | APEak	3.6-56
[SENSe]:DETector[:FUNCtion]:AUTO	ON | OFF	3.6-56
[SENSe:]DDEMod:FILTer:ALPHa	0.2...1	3.6-59
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[SENSe:]DDEMod:FORMat	QPSK | PSK | MSK	3.6-57
[SENSe:]DDEMod:MSK:FORMat	TYPE1 | TYPE2	3.6-58
[SENSe:]DDEMod:NORMalize	ON | OFF	3.6-59
[SENSe:]DDEMod:PRATe	1 | 2 | 4 | 8 | 16	3.6-58
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Command	Parameter	Page
[SENSe:]DDEMod:PSK:NSTate	2 | 8	3.6-58
[SENSe:]DDEMod:QPSK:FORMat	NORMal | DIFFerential | DPI4	3.6-57
[SENSe:]DDEMod:SEARch:PULSe:STATe	ON | OFF	3.6-59
[SENSe:]DDEMod:SEARch:SYNC:OFFSet	<numeric_value>	3.6-59
[SENSe:]DDEMod:SEARch:SYNC:PATTern	<string>	3.6-60
[SENSe:]DDEMod:SEARch:SYNC:STATe	ON | OFF	3.6-60
[SENSe:]DDEMod:SEARch:TIME	100 | 200 | 400 | 800	3.6-60
[SENSe:]DDEMod:SRATe	160 Hz to 1.6 MHz	3.6-58
[SENSe:]DDEMod:TIME	1...Frame Length	3.6-58
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[SENSe:]FREQuency:CENTer:LINK	STARt | STOP | SPAN	3.6-61
[SENSe:]FREQuency:CENTer:STEP	0 to fmax	3.6-62
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[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor	1 to 100 PCT	3.6-62
[SENSe:]FREQuency:SPAN	0 GHz to fmax	3.6-62
[SENSe:]FREQuency:SPAN:FULL		3.6-63
[SENSe:]FREQuency:SPAN:LINK	CENTer | STOP | SPAN	3.6-63
[SENSe:]FREQuency:STARt	0 GHz to fmax	3.6-63
[SENSe:]FREQuency:STARt:LINK	CENTer | STOP | SPAN	3.6-63
[SENSe:]FREQuency:STOP	0 GHz to fmax	3.6-64
[SENSe:]FREQuency:STOP:LINK	CENTer | STARt | SPAN	3.6-64
[SENSe]:ROSCillator:EXTernal:FREQuency	1MHz to 16MHz	3.6-65
[SENSe]:ROSCillator:SOURce	INTernal | EXTernal	3.6-65
[SENSe:]SWEep:COUNt	0 to 32767	3.6-67
[SENSe:]SWEep:EGATe	ON | OFF	3.6-67
[SENSe:]SWEep:EGATe:HOLDoff	0 to 100s	3.6-68
[SENSe:]SWEep:EGATe:LENGth	0 to 100s	3.6-68
[SENSe:]SWEep:EGATe:LEVel	-5V to +5V	3.6-67
[SENSe:]SWEep:EGATe:POLarity	POSitive | NEGative	3.6-68
[SENSe:]SWEep:EGATe:TYPE	LEVel | EDGE	3.6-67
[SENSe:]SWEep:GAP	ON | OFF	3.6-68
[SENSe:]SWEep:GAP:PRETrigger	0 to 100s	3.6-69
[SENSe:]SWEep:GAP:TRGTogap	0 to 100s	3.6-69
[SENSe:]SWEep:GAP:LENGth	0 to 100s	3.6-69

Command	Parameter	Page
[SENSe:]SWEep:TIME	5ms to 1000s	3.6-66
[SENSe:]SWEep:TIME:AUTO	ON | OFF	3.6-66
[SENSe:]TCAPture:LENGth	1024 | 2048 | 4096 | 8192 | 16384	3.6-60
STATus:OPERation:CONDition?		3.6-71
STATus:OPERation:ENABle	0 to 65535	3.6-71
STATus:OPERation[:EVENt?]		3.6-71
STATus:OPERation:NTRansition	0 to 65535	3.6-71
STATus:OPERation:PTRansition	0 to 65535	3.6-71
STATus:PRESet		3.6-71
STATus:QUEStionable:CONDition?		3.6-72
STATus:QUEStionable:ENABle	0 to 65535	3.6-72
STATus:QUEStionable[:EVENt?]		3.6-72
STATus:QUEStionable:NTRansition	0 to 65535	3.6-73
STATus:QUEStionable:PTRansition	0 to 65535	3.6-72
STATus:QUEStionable:LIMit:CONDition?		3.6-70
STATus:QUEStionable:LIMit:ENABle	0 to 65535	3.6-70
STATus:QUEStionable:LIMit[:EVENt?]		3.6-70
STATus:QUEStionable:LIMit:NTRansition	0 to 65535	3.6-70
STATus:QUEStionable:LIMit:PTRansition	0 to 65535	3.6-70
STATus:QUEStionable:LMARgin:CONDition?		3.6-70
STATus:QUEStionable:LMARgin:ENABle	0 to 65535	3.6-70
STATus:QUEStionable:LMARgin[:EVENt?]		3.6-70
STATus:QUEStionable:LMARgin:NTRansition	0 to 65535	3.6-70
STATus:QUEStionable:LMARgin:PTRansition	0 to 65535	3.6-70
STATus:QUEStionable:POWer:CONDition?		3.6-70
STATus:QUEStionable:POWer:ENABle	0 to 65535	3.6-70
STATus:QUEStionable:POWer[:EVENt?]		3.6-70
STATus:QUEStionable:POWer:NTRansition	0 to 65535	3.6-70
STATus:QUEStionable:POWer:PTRansition	0 to 65535	3.6-70
STATus:QUEStionable:SYNC:CONDition?		3.6-70
STATus:QUEStionable:SYNC:ENABle	0 to 65535	3.6-70
STATus:QUEStionable:SYNC[:EVENt?]		3.6-70
STATus:QUEStionable:SYNC:NTRansition	0 to 65535	3.6-70
STATus:QUEStionable:SYNC:PTRansition	0 to 65535	3.6-70

Command	Parameter	Page
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	0...30	3.6-74
SYSTem:COMMunicate:GPIB:RDEVice<1|2>:ADDRess	0 to 30	3.6-75
SYSTem:COMMunicate:SERial<1|2>:CONTrol:DTR	IBFull | OFF	3.6-75
SYSTem:COMMunicate:SERial<1|2>:CONTrol:RTS	IBFull | OFF	3.6-75
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD	<numeric_value>	3.6-75
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITS	7 | 8	3.6-75
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PACE	XON | NONE	3.6-76
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARity[:TYPE]	EVEN | ODD | NONE	3.6-76
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:SBITs	1 | 2	3.6-76
SYSTem:DATE	1980 to 2099, 1 to 12, 1 to 31	3.6-76
SYSTem:ERRor?		3.6-77
SYSTem:PASSword[:CENable]	'password'	3.6-77
SYSTem:PRESet		3.6-77
SYSTem:SPEaker:VOLume	0 to 1	3.6-77
SYSTem:TIME	0 to 23, 0 to 59, 0 to 59	3.6-78
SYSTem:VERSion?		3.6-78
TRACe[:DATA]	TRACe1 | TRACe2 | TRACe3 | TRACe4, <block>|<numeric_value>	3.6-79
TRIGger[:SEQuence]:HOLDoff	0 to 100s	3.6-80
TRIGger[:SEQuence]:LEVel	0 to 100% (TRIG:SOUR VID) or –5.0 to +5.0V (TRIG:SOUR EXT)	3.6-80
TRIGger[:SEQuence]:SLOPe	POSitive | NEGative	3.6-81
TRIGger[:SEQuence]:SOURce	IMMediate | LINE | EXTernal | VIDeo	3.6-80
UNIT:POWer	DBM | DBPW | WATT | DBUV | VOLT | DBUA | AMPere	3.6-82
UNIT:PROBe	ON | OFF	3.6-82

Annex D – Programming Examples

The examples explain the programming of the instrument and can serve as a basis to solve more complex programming tasks.

QuickBASIC has been used as programming language. However, the programs can be translated into other languages.

D.1 Including IEC-Bus Library for QuickBasic

```
REM ----------- Include IEC-bus library for quickbasic ---------------
'$INCLUDE: 'c:\qbasic\qbdecl4.bas'
```

D.2 Initialization and Default Status

The IEC bus as well as the settings of the instrument are brought into a defined default status at the beginning of every program. Subroutines "InitController" and "InitDevice" are used to this effect.

D.2.1 Initiate Controller

```
REM ------------ Initiate controller -----------
REM InitController
iecaddress% = 20                          'IEC-bus address of the
                                          'instrument
CALL IBFIND("DEV1", analyzer%)            'Open port to the instrument
CALL IBPAD(analyzer%, iecaddress%)        'Inform controller on instrument
                                          'address
CALL IBTMO(analyzer%, 11)                 'Response time to 1 sec
REM ********************************************************************
```

D.2.2 Initiate Instrument

The IEC-bus status registers and instrument settings of the analyzer are brought into the default status.

```
REM ------------ Initiate instrument --------------
REM InitDevice
CALL IBWRT(analyzer%, "*CLS")           'Reset status register
CALL IBWRT(analyzer%, "*RST")           'Reset instrument
REM*********************************************************************
```

D.3 Transmission of Instrument Setting Commands

Center frequency, span, and reference level of the analyzer are set in this example.

```
REM -------- Instrument setting commands ------------
CALL IBWRT(analyzer%, "FREQUENCY:CENTER 120MHz")    'Center frequency 120 MHz
CALL IBWRT(analyzer%, "FREQUENCY:SPAN 10MHZ")       'Span 10 MHz
CALL IBWRT(analyzer%, "DISPLAY:TRACE:Y:RLEVEL -10dBm")
                                                    'Reference level -10dBm
REM ***************************************************************************
```

D.4 Switchover to Manual Control

```
REM -------- Switch instrument over to manual control -----------
CALL IBLOC(analyzer%)                          'Set instrument to Local state
REM ***************************************************************************
```

D.5 Reading out Instrument Settings

The settings made in example 3 are read out here. The abbreviated commands are used.

```
REM --------- Reading out instrument settings ---------
CFfrequency$ = SPACE$(20)             'Provide text variables (20 characters)
CALL IBWRT(analyzer%, "FREQ:CENT?")   'Request center frequency
CALL IBRD(analyzer%, CFfrequency$)    'Read value

CFspan$ = SPACE$(20)                  'Provide text variables (20 characters)
CALL IBWRT(analyzer%, "FREQ:SPAN?")   'Request span
CALL IBRD(analyzer%, CFspan$)         'Read value

RLevel$ = SPACE$(20)                  'Provide text variables (20 characters)
CALL IBWRT(analyzer%, "DISP:TRAC:Y:RLEV?")
                                      'Request reference level
CALL IBRD(analyzer%, RLevel$)         'Read value

REM -------- Display values on the screen -----------
PRINT "Center frequency: "; CFfrequency$,
PRINT "Span:             "; CFspan$,
PRINT "Reference level:  "; RLevel$,
REM***************************************************************************
```

D.6 Positioning a Marker and Displaying Values

```
REM -------- Examples of marker functions -----------
CALL IBWRT(analyzer%, "CALC:MARKER ON;MARKER:MAX")
                                  'Activate marker1 and start peak search
MKmark$ = SPACE$(30)              'Provide text variables (30 characters)
CALL IBWRT(analyzer%, "CALC:MARK:X?;Y?")    'Request frequency and level
CALL IBRD(analyzer%, MKmark$)               'Read value

REM -------- Display values on the screen -----------
PRINT "Center frequency / level "; MKmark$,
REM ***************************************************************************
```

D.7 Command synchronization

The possibilities for synchronization implemented in the following example are described in Section 3.7.6, Command Order and Command Synchronization.

```
REM -------- Examples of command synchronization ---------
REM The command INITiate[:IMMediate] starts a single sweep if the command
REM INIT:CONT OFF was previously sent. It should be ensured that the next
REM command is only then executed when the entire sweep is complete.

CALL IBWRT(analyzer%, "INIT:CONT OFF")

REM -------- First possibility: Use of *WAI ---------
CALL IBWRT(analyzer%, "ABOR;INIT:IMM; *WAI")

REM -------- Second possibility: Use of *OPC? ---------
OpcOk$ = SPACE$(2)                  'Space for *OPC? - Provide response
CALL IBWRT(analyzer%, "ABOR;INIT:IMM; *OPC?")
REM -------- here the controller can service other instruments ---------
CALL IBRD(analyzer%, OpcOk$)        'Wait for "1" from *OPC?

REM -------- Third possibility: Use of *OPC ---------
REM In order to be able touse the service request function in conjugation
REM with a National Instruments GPIB driver, the setting "Disable
REM Auto Serial Poll" must be changed to "yes" by means of IBCONF!

CALL IBWRT(analyzer%, "*SRE 32")      'Permit service request for ESR
CALL IBWRT(analyzer%, "*ESE 1")       'Set event-enable bit for
                                      'operation-complete bit
ON PEN GOSUB OpcReady                 'Initialization of the
                                      'service request routine
PEN ON
CALL IBWRT(analyzer%, "ABOR;INIT:IMM; *OPC")

REM Continue main program here
STOP                                  'End of program

OpcReady:
REM As soon as the sweep has ended, this subroutine is activated
REM Program suitable reaction to the OPC service request.
ON PEN GOSUB OpcReady                 'Enable service request routine again
RETURN
REM ************************************************************************
```

D.8 Service Request

The service request routine requires an extended initialization of the instrument in which the respective bits of the transition and enable registers are set.
In order to use the service request function in conjugation with National Instruments GPIB driver, the setting "Disable Auto Serial Poll" must be changed to "yes" by means of IBCONF!

```
REM ---- Example of initialization of the SRQ in the case of errors  ------
CALL IBWRT(analyzer%, "*CLS")                    'Reset Status Reporting System
CALL IBWRT(analyzer%,"*SRE 168")                 'Permit service request for
                                                 'STAT:OPER,STAT:QUES and ESR
                                                 'register
CALL IBWRT(analyzer%,"*ESE 60")                  'Set event-enable bit for
                                                 'command, execution, device-
                                                 'dependent and query error
CALL IBWRT(analyzer%,"STAT:OPER:ENAB 32767")     'Set OPERation enable bit for
                                                 'all events
CALL IBWRT(analyzer%,"STAT:OPER:PTR 32767")      'Set appropriate OPERation
                                                 'Ptransition bits
CALL IBWRT(analyzer%,"STAT:OPER:ENAB 32767")     'Set questionable enable bits
                                                 'for all events
CALL IBWRT(analyzer%,"STAT:OPER:PTR 32767")      'Set appropriate questionable
                                                 'Ptransition bits
ON PEN GOSUB Srq                                 'Initialization of the service
                                                 'request routine
PEN ON
REM Continue main program here
STOP
```

A service request is then processed in the service request routine.
Note: the variables userN% and userM% must be pre-assigned usefully!

```
Srq:
REM ------------ Service request routine -----------
DO
   SRQFOUND% = 0
   FOR I% = userN% TO userM%                     'Poll all bus users
        ON ERROR GOTO nouser                     'No user existing
        CALL IBRSP(I%, STB%)                     'Serial poll, read status byte
        IF STB% > 0 THEN                         'This instrument has bits set
                                                 'in the STB
           SRQFOUND% = 1
           IF (STB% AND 16)  > 0 THEN GOSUB Outputqueue
           IF (STB% AND 4)   > 0 THEN GOSUB Failure
           IF (STB% AND 8)   > 0 THEN GOSUB Questionablestatus
           IF (STB% AND 128) > 0 THEN GOSUB Operationstatus
           IF (STB% AND 32)  > 0 THEN GOSUB Esrread
        END IF
nouser:
   NEXT I%
LOOP UNTIL SRQFOUND% = 0
ON ERROR GOTO error handling
ON PEN GOSUB Srq: RETURN                         'Enable SRQ routine again
                                                 'End of SRQ routine
```

Reading out the status event registers, the output buffer and the error/event queue is effected in subroutines.

```
REM -------- Subroutines for the individual STB bits ------
Outputqueue:                                    'Reading the output buffer
Message$ = SPACE$(100)                          'Make space for response
CALL IBRD(analyzer%, Message$)
PRINT "Message in output buffer :"; Message$
RETURN

Failure:                                        'Read error queue
ERROR$ = SPACE$(100)                            'Make space for error variable
CALL IBWRT(analyzer%, "SYSTEM:ERROR?")
CALL IBRD(analyzer%, ERROR$)
PRINT " Error text :"; ERROR$
RETURN


Questionablestatus:                         'Read questionable status register
Ques$ = SPACE$(20)                          'Preallocate blanks to text variable
CALL IBWRT(analyzer%, "STATus:QUEStionable:EVENt?")
CALL IBRD(analyzer%, Ques$)
PRINT "Questionable Status:"; Ques$
RETURN

Operationstatus:                            'Read operation status register
Oper$ = SPACE$(20)                          'Preallocate blanks to text variable
CALL IBWRT(analyzer%, "STATus:OPERation:EVENt?")
CALL IBRD(analyzer%, Oper$)
PRINT "Operation Status:"; Oper$
RETURN


Esrread:                                    'Read event status register
Esr$ = SPACE$(20)                           'Preallocate blanks to text variable
CALL IBWRT(analyzer%, "*ESR?")              'Read ESR
CALL IBRD(analyzer%, Esr$)
IF (VAL(Esr$) AND 1) > 0 THEN PRINT "Operation complete"
IF (VAL(Esr$) AND 4) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 8) > 0 THEN PRINT "Device dependent error"
IF (VAL(Esr$) AND 16) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 32) > 0 THEN GOTO Failure
IF (VAL(Esr$) AND 64) > 0 THEN PRINT "User request"
IF (VAL(Esr$) AND 128) > 0 THEN PRINT "Power on"
RETURN
REM ************************************************************************

REM ------------- Error routine ---------------
Error handling:
PRINT "ERROR                                'Output error message
STOP                                        'Stop software
```

...lations

...of Display Elements

...a mouse (see Chapter ... using a Mouse").

...(Measurement Values not here ... in the Measurements Book.) This)
...display screen can also be ... Enter's exit key or

...rollable display elements and the assigned keys:

Annex E - Emulations

E.1 Mouse Control of Display Elements

The FSE can be optionally equipped with a mouse (see Chapter 1 "Connecting a Mouse").

All display and control elements (enhancement labels, soft keys, function fields, display and limit lines) which can be displayed on the display screen can also be controlled by the mouse. Each soft key or key is assigned to a display element.

The following table lists the controllable display elements and the assigned keys

Display element for mouse control.		Assigned soft key or key
Display field for Soft Key 1 to Soft Key 10		Soft Key 1 to Soft Key 10
Display field for menu arrow: right/center/left		Key right/center/left supplementary menu
Enhancement labels	*	--
	PA	SETUP key
	PS	SETUP key
	UNS	COUPLING key
	LVL	REF key
	FRQ	CENTER key
	1-x	TRACE 1 key
	2-x	TRACE 2 key
	3-x	TRACE 3 key
	4-x	TRACE 4 key
	TRG	TRIGGER key
	DC	INPUT key
	75Ω	INPUT key
	MAC	USER key
Status display	UNCAL	CAL key
	OVLD	REF key
	ERR	INFO key
Display fields above the diagram		
	Ref. Level / Max Level	REF key
	Marker	NORMAL key
	RBW	COUPLING key
	VBW	COUPLING key
	SWT	COUPLING key
	RF Att	INPUT key
	Mixer	INPUT key
	Unit	REF key
Display fields below the diagram		
	Start	START key
	Stop	STOP key
	Center	CENTER key
	Span	SPAN key
	Trigger	TRIGGER key
	/Div	--

E.2 Front Panel Keyboard Emulation

The FSE can be equipped with an optional external keyboard.(see Chapter 1 "Connecting an External Keyboard"). The following table shows the external keyboard key combinations through which the functions of the front panel keys can be emulated.

Note:
- *The key combination <ALT><S-Abf> (German keyboard) or <ALT> <SYSREQ> (English keyboard) switches between the instrument display screen and the DOS display screen.(for an installed processor option FSE-B15).*
- *In instrument mode, the key combination <ALT> <F1> switches the keyboard between the US-American language and the language selected in the GENERAL SETUP* menu.

FSE front panel keys		Key assignments for the external keyboard
Soft keys:	SK1	F1
	SK2	F2
	SK3	F3
	SK4	F4
	SK5	F5
	SK6	F6
	SK7	F7
	SK8	F8
	SK9	F9
	SK10	F10
Menu select:	Menu left	CTRL ←
	Menu right	CTRL →
	Menu up	CTRL ↑
Cursor control:	Cursor left	←
	Cursor right	→
	Cursor up	↑
	Cursor down	↓
Roll-key:	Turn left	SHIFT ↑
	Turn right	SHIFT ↓
Numeric keys:	0	0
	1	1
	2	2
	3	3
	4	4
	5	5
	6	6
	7	7
	8	8
	9	9
Units keys:	GHz...	ALT-G
	MHz...	ALT-M
	kHz...	ALT-K
	Hz...	<ENTER>
Edit keys:	Clear	<ESC>
	Backspace	BACK
Misc. data entry keys:		
	Exponent "Exp"	ALT-E
	Sign "+/-"	-
	Decimal point"."	.
Hold key:	Hold	SHIFT-F1
User menu:	User	SHIFT-F2
System keys:	Preset	SHIFT-F4
	Cal	ALT-F12
	Display	ALT-F10
	Info	SHIFT-F5

FSE front panel keys		Key assignments for the external keyboard
Configuration key group:	Mode	ALT-F2
	Setup	SHIFT-F8
Hardcopy key group:	Start	SHIFT-F6
	Setting	SHIFT-F9
Status key group :	Local	SHIFT-F3
Frequency key group:	Start	CTRL-F7
	Stop	CTRL-F8
	Center	CTRL-F9
	Span	CTRL-F10
Level key group:	Reference	CTRL-F11
	Range	CTRL-F12
	Input	ALT-F11
	Cal	ALT-F12
Marker key group :	Normal	CTRL-F1
	Search	CTRL-F2
	Delta	CTRL-F3
	→ Mkr	CTRL-F4
Lines key group :	Display	CTRL-F5
	Limit	CTRL-F6
Traces key group :	1	ALT-1
	2	ALT-2
	3	ALT-3
	4	ALT-4
Sweep key group :	--	ALT-F3
	--	ALT-F4
	--	ALT-F5
	Coupl.Fcts.	ALT-F6
	Sweep	ALT-F7
	Trigger	ALT-F8
Memory key group:	Config	SHIFT-F10
	Save	SHIFT-F11
	Recall	SHIFT-F12
Data entry key group :	Step	SHIFT-F7
Letters and special characters		A to Z (ext.) a to z (ext.) Special characters (ext.)
Edit key		Delete
Cursor control		Home End Page up Page down

E.2 Front Panel Keyboard Emulation

The FSE can be equipped with an optional external keyboard (see Chapter 1 "Operating on Keyboard"). The following table shows the external keyboard key combinations through which functions of the front panel keys can be emulated

Note: – The key combination <ALT-G-Abb> (German keyboard) or <ALT-S-Abb> (US-American keyboard) switches between the alternative keyboard layouts. Upon delivery of the FSE the screen for an installed proce ssor option FSE-B15 ...
– In instrument mode, the key combination <ALT> switches the keyboard between the US-American language and the language selected in the GERÄTEEINSTELLUNG menu.

FSE front panel keys		Key assignments for the external keyboard
Softkeys	SK1	F1
	SK2	F2
	SK3	F3
	SK4	F4
	SK5	F5
	SK6	F6
	SK7	F7
	SK8	F8
	SK9	F9
	SK10	F10
Menu selection	Menu left	CTRL ←
	Menu right	CTRL →
	Menu up	CTRL ↑
Cursor control	Cursor left	←
	Cursor right	→
	Cursor up	↑
	Cursor down	↓
Shift key	"numeric"	F12
	"num edit"	SHIFT ↓
Numeric keys	0	0
	.	.
	1	1
	2	2
	3	3
	4	4
	5	5
	6	6
	7	7
	8	8
	9	9
Units keys	GHz	ALT-G
	MHz	ALT-M
	kHz	ALT-K
	Hz	<ENTER>
Edit keys	Clear	<BACK>
	Backspace	<BACK>
Miscellaneous keys	Decimal point "Edit"	ALT-E
	Sign "+/-"	
	Decimal point	
Hold key	Hold	SHIFT-H
User menu	User	SHIFT-U
System keys	Preset	SHIFT-P
	Help	SHIFT-H
	Delete	ALT-DEL
	Esc	SHIFT-ESC

FSE front panel keys		Key assignments for the external keyboard
Config. menu group	Mode	ALT-F2
	Setup	SHIFT-F2
Hardcopy key group	Print	F3
	Start	SHIFT-F3
Trace key group	Trace	F4
Frequency key group	Center	F5
	Span	SHIFT-F5
	Start	ALT-F5
	Stop	F6
Level key group	Reference level	SHIFT-F6
	Offset	ALT-F6
	Range	F7
Marker key group	Marker	SHIFT-F7
	Marker to peak	ALT-F7
	Delta	F8
	Marker to center	SHIFT-F8
Trace key group	1	1
	2	2
	3	3
	4	4
Sweep key group	Single	SHIFT-1
	Cont	SHIFT-2
Memory key group	Config	SHIFT-3
	Save	SHIFT-4
	Recall	SHIFT-5
Softkey entry key	Help	SHIFT-6
Softkeys	Softkeys 1 to 8	F1 to F8
	Softkey 9	SHIFT-F1
	Softkey 10	SHIFT-F2